SCIENCE

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CONTENTS:

The War with the Microbes: E. A. DE SCHWEINITZ..561
The Growth of Children: FRANZ BOAS.....570
The Promise and Potency of High Pressure Steam: R. H. THURSTON.....573
The Origin of the Teeth of the Mammalia: HENRY F. OSBORN.....576
Zoological Notes:—
The Sharp-tailed Finches of Maine: A. K. FISHER.577
Current Notes on Physiography:—
Yellowstone National Park; Bearpaw Mountains, Montana; Laurentian Highlands of Canada; Maps of Mt. Desert: W. M. DAVIS.....577
Current Notes on Anthropology:—
The Progress of Anthropology; The Lumbar Curve; Native American Mysticism: D. G. BRINTON....578
Scientific Notes and News.....579
University and Educational News.....584
Discussion and Correspondence:—
Diffraction of X-Rays obtained by a New Form of Cathode Discharge: R. W. WOOD. *The Height and the Velocity of the Flight of a Flock of Geese Migrating Northward:* H. HELM CLAYTON. *Archæological Discoveries made in the Gravels at Trenton:* G. FREDERICK WRIGHT, D. G. BRINTON. *An Imaginary Fleet:* G. D. HARRIS. *The Metric System:* BURT G. WILDER.....585
Scientific Literature:—
The Formation of the Quarternary Deposits of Missouri: O. H. HERSHEY. *Peters' Angewandte Elektrochemie:* EDGAR F. SMITH.....587
Scientific Journals:—
American Journal of Science; The Astrophysical Journal.....589
Societies and Academies:—
Zoological Club of the University of Chicago. The Anthropological Society of Washington: J. H. MCCORMICK. *The New York Academy of Sciences—Biological Section:* BASHFORD DEAN. *The Torrey Botanical Club:* EDWARD S. BURGESS.....592
New Books.....596

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*THE WAR WITH THE MICROBES.**

FROM the moment that man made his appearance in the world there has been perpetual warfare between himself and everything animate and inanimate upon the earth. To a great extent this has been an aggressive strife, man's every effort being exerted to compel nature to contribute to his comfort, welfare and advancement by the subjugation of her materials and forces. It was many centuries, however, before he recognized that there were certain unknown insidious enemies, which often rendered fruitless his simple household occupations, defied his every effort at control and sometimes menaced even his well-being and life. Though in 1675 Leeuwenhoeck discovered, with a powerful magnifying glass, certain minute organisms in decomposing animal matter, it was not until nearly two centuries later that their true significance was recognized, and Davaine first demonstrated the positive connection between these minute forms of life and disease. When animal and vegetable life ceased, in accordance with the laws of nature, they were supposed to be changed by purely chemical actions, so that their elements were again returned to the earth and air to supply food for other plants and animals. This destruction was considered to be wrought simply by the oxygen of the air, and the process of

*Address of the President before the Chemical Society of Washington, March 9, 1897.

fermentation was thought to be due to a similar cause. It had been known for ages that the juice of the grape, if allowed to stand, underwent changes by which its character was modified and wine was formed, or this change might be allowed to progress further until the juice had been converted into vinegar and finally carbon dioxide gas and water. These alterations, those which take place in the digestive tract of animals and are involved in the conversion of dead animal and plant matter into their simplest constituents, were classed under the general head of fermentations.

The fermentations, especially that of wine, an Italian chemist, Fabroni, in 1822, supposed to be induced by a substance of vegetable origin, but closely allied to the white of egg. He considered this material identical with the gluten of cereals and gave to it the name of the 'principle vegeto-animal.' For nearly forty years afterwards this theory was applied by chemists to all fermentations. It was supposed that the albuminoid substance present exposed to the oxygen of the air experienced a progressively variable alteration, that diverse modifications of matter were produced which constituted the ferments of diverse nature. The fermentation was the result of the molecular movement thus communicated. These theories were based upon an erroneous interpretation of what occurred under certain conditions. There exists in wine, when it is being converted into vinegar, a substance which acts to bring about this modification, but this is not dead albuminoid matter, but a living plant. This fact the lamented chemist, Pasteur, demonstrated in his careful studies upon the production of wine and its conversion into vinegar. Before this time, it is true, there were many who failed to accept the theory of spontaneous oxidation, and endeavored to show that if fermentable liquids were boiled in flasks which were then immediately sealed, the fermentation could not take place. But this did not fulfill the demands of one school of chemists, viz., that plenty of oxygen gas should always be present. When the liquid was boiled in contact with air which had previously been drawn through sulphuric acid, it was claimed that the air had undergone some chemical change, so it was not until 1854 that this objection was overcome by previously passing the air in the presence of which boiling took place through cotton, and it was then that this school of chemists found their theories in danger. Pasteur demonstrated that the plant present in the preparation of vinegar was the simplest form of life, a cell which could be easily destroyed by heat. Its presence was absolutely necessary for fermentation, and without the living cell no amount of dead vegetable matter could cause the peculiar molecular disarrangement which had been claimed. While Liebig had contended that as long as the juice of the grape remained away from contact with the oxygen of the air the necessary motion could not be imparted to the molecules, which movement subsequently caused the phenomena of fermentation. Thus was brought to an end the strife between the two schools of vitalists and chemists; the one school of chemists demanding the presence of ogygen only, the other the presence of a living plant cell in addition to oxygen. From this strife of the two schools was evolved in reality a new science and new theories, which have made the past thirty years marvelous in their explanations of many of the simplest phenomena of plant and animal life and death, placed the practice of medicine upon a scientific basis and rendered possible an intelligent system of agriculture and animal husbandry.

Pasteur's discoveries also served to explain the true cause of the poisonous properties of spoiled meats and other foods, stagnant

water, and water from marshy countries. For more than half a century before this time a number of investigators had proved the dangerous character of old sausage meats, bread and the like. Kerner concluded that they contained a fatty acid to which the poisonous action was due; others confirmed these ideas and came to similar conclusions in regard to poisonous cheese. In 1856 Panum asserted, as a result of his studies upon the poisons found in putrid animal matter, that these poisons might be formed by some active plant cell, but their injurious effect was independent of these cells. He demonstrated that fixed non-volatile poisons could be extracted from putrid matter which were soluble in water and alcohol, not destroyed by heat, and produced the same effects after they had been submitted to a high temperature as before. These poisons he found to be intense in their action, 0.012 grams sufficing to cause the death of a small animal. In 1866 Bence-Jones obtained from the liver a substance which, with dilute sulphuric acid, gave a bright blue fluorescence like that noted in similar solutions of quinine. Probably this was the product of what we now call fluorescing bacteria.

The work of Pasteur threw light upon the origins of these poisons. As the ferment causes the alteration in the grape juice, so do microscopic forms of life bring about the changes which take place in dead animal and vegetable matter, and also those conditions in the living body which we call disease.

Many of these microscopic forms of single-celled plants, *the bacteria*, have their natural habitat upon dead organic matter, but they may flourish in the living body and are almost unlimited in variety, appearance and behavior. It is possible also to cultivate them upon specially prepared solutions after their individual peculiarities have been studied. Some thrive best in light, others in darkness; some like a goodly supply of oxygen, others prefer nitrogen; some are very sensitive to changes of temperature, while others readily accustom themselves to vicissitudes.

These different bacteria further are somewhat eccentric within as well as without the animal body. Some, as the diphtheria germs, find their most comfortable habitat upon certain mucous membranes, others in the lungs, some in the digestive tract, still others in the blood, while others again confine themselves to certain external cells and membranes. In their artificial cultivation this eccentricity is equally apparent. While nearly all thrive upon a beef broth, some prefer the beef broth with an excess of acid, others with an excess of alkali. Some demand the addition of sugar or glycerine, others the addition of sugar together with acid, while some are satisfied with a diet of phosphates, salt and water. These peculiarities have to be studied for each germ, and while many can accommodate themselves to their surroundings, and while the same germ grown upon different media produces the *same substances*, the amount of each substance is a varying one, and in cultivating them artificially we must find which diet gives rise to the largest amount of the most active products.

Shortly after the work of Panum just referred to, the Italian chemist Selmi outlined methods of extracting poisonous principles from dead animal matter, and gave to these substances the name ptomaines, on account of their origin. Later, in 1876, the first analysis of a ptomaine was made by Nencki and its formula determined. Further experiments showed that volatile and non-volatile substances, alkaline in character, could be obtained from various portions of the animal body, often from fresh material and also from the cultures of bacteria. These ptomaines were found to resemble the alkaloids in their chemical reactions.

In 1882–83 Brieger succeeded in separa-

ting and determining a number of these ptomaines, from the brain, from fish muscarin, from decomposed glue, neuridine and dimethyl amine, muscarin, etc. From pure cultures of the typhoid germ he obtained a substance, typhotoxin, which produced typhoid symptoms, and from cultures of the tetanus germ tetanin, which caused convulsions. The presence of similar poisonous bases was demonstrated in cultures of the cholera, hog cholera, anthrax, pyogenes aureus and like active bodies were isolated from cheese, milk, ice cream, sausage and other foods which had caused sickness.

The isolation of these poisons from bacterial cultures gave rise to the belief that they were the bodies which caused the fatal effects of disease. But while in many instances they produced the characteristic symptoms, in others they were not sufficient to account for all the phenomena. For example, from cultures of the tetanus germ it was possible to isolate a base that had but slight poisonous properties, while the culture liquid from which this was obtained after all the germs had been removed was ten thousand times more poisonous than the base secured. Non-poisonous ptomaines were also obtained from cultures of disease-producing bacteria, and, in fact, the majority of ptomaines were found to be non-poisonous.

The next question was, if in the culture liquids freed from bacteria, poisonous substances are obtained, and if they do not belong to the class of ptomaines, how shall they be identified and classified? In 1886 Mitchell and Reichert, while studying the venoms of serpents, noted that these poisons belonged to a class of bodies different from the ptomaines, viz., to the group called proteids. Shortly after, Roux and Yersin, in their studies upon the diphtheria poison, demonstrated that this was a substance which resembled the ferments and led them to think that an enzyme, as it is called, a substance like pepsin, was the active poison, and that this enzyme was in some way elaborated by the germ. Other investigators had found a similar substance in tetanus and hog cholera cultures, and a reinvestigation by Brieger of a number of bacterial cultures showed that by precipitation with ammonium sulphate and alcohol very poisonous substances giving proteid reactions could be obtained. Proteids of various characters belonging to different classes were obtained from cultures of many bacteria. About this time it was shown that certain plants of a higher order contained poisonous bodies of a like proteid character. An albumose abrin was obtained from the Jequirity seeds and ricin from the castor-oil bean. These were intensely poisonous, $\frac{1}{100000}$ of a grain of abrin being sufficient to kill an animal weighing one kilogram, or the $\frac{1}{100}$ of a grain should be a fatal dose for a man weighing about 130 pounds.

A relationship was thus established between the poisons from higher plants and from the lowest plants and certain animals. Was this poisonous property of these bacterial substances due to a true proteid, or was there an admixture of an active ferment-like substance with the proteid, and are these poisons mechanically carried down in the process of precipitation of the albuminoid matter in the culture liquids? Experiments show that while the poisons may be proteids, it is more than probable that they are simply carried down with proteid matter as indicated. Brieger in 1893, in view of the results so far obtained, endeavored to isolate the pure poison from cultures of the tetanus bacillus. The cultures were first filtered through porous porcelain, a Chamberland or Monroe filter tube, for instance, and the liquid which passed through was treated with a concentrated solution of ammonium sulphate. This preciptated the poisons and a number of other substances

which gave proteid reactions. After purification and dialysis the poison was obtained as yellow soluble flakes which no longer gave proteid reactions. It was a substance in which there was no noticeable phosphorus nor sulphur. It was thus proved that the tetanus poison belonged neither to the ptomaines before referred to, nor to the proteids. The poison, while not perfectly pure, was purer than any ever before obtained, and was so poisonous that a mouse weighing $\frac{1}{2}$ oz. was killed by $\frac{1}{1,125,000}$ part of a grain, while $\frac{1}{250}$ of a grain should kill a man weighing 150 lbs.

It is not difficult to understand how if the tetanus bacillus outside of the body can produce such powerful poisons, it can give rise in the animal organism to serious troubles. The diphtheria bacillus is another germ which forms very powerful poisons in the solutions upon which it feeds. As already mentioned, some authors, Roux and Yersin, believe that this poison also belongs to the ferments like trypsin and pepsin, while Brieger and Fraenkel thought it was a toxalbumin. We find after the germ has been removed from the culture liquid by filtration, that the poison can be separated by calcium phosphate or ammonium sulphate, just like the tetanus poison. In the purest condition in which it has been so far obtained it fails to give the proteid reaction, and $\frac{1}{44}$ of a grain will kill a guinea pig. It dialyses readily. Bodies of a similar kind have been obtained from cholera, glanders, swine plague, tuberculosis, and anthrax cultures, while many other bacteria produce soluble intensely poisonous substances in artificial cultures as well as inside the animal body.

These products are all characteristic of the individual organism. The conditions under which the most poisonous ones are formed seem to be dependent partly, we may say, upon the humor of the germ and also upon the food offered for its use. It appears, for example, in connection with the diphtheria germ that, if there happens to be present in the beef broth upon which it is being cultivated, an undue amount of glucose and an insufficient supply of alkali, that, instead of producing a very active poison, the substance secreted is much less harmful. This is accounted for by the supposition that the glucose is decomposed into acid which, in its turn, neutralizes or decomposes the poison ordinarily produced by the germ. These poisons, it was originally supposed, resulted from the decomposition of the food of the germ, just as soluble and assimilable albuminoids are produced by the acids and ferments of the animal body from the insoluble albuminoids that are ingested as food. It has been found, however, that in most instances the poison of the germ is in solution in quantity only after the germs themselves have become partially disintegrated. In other words, the active bacterial poisons seem to be products of the cell and retained within the cell until the latter dies and the cell membrane is broken, permitting the passage into the surrounding liquid of the poison. What then is the true nature of these poisons if they belong neither to the bases nor to the proteids or toxalbumins? That, unfortunately, is one of the problems to which, up to the present time, chemical research has not been able to give a definite answer; and this, because, as we have already noted, the poisons of these bacteria are so tremendously active and consequently produced in proportionately small amount, even when a large quantity of the culture media is used, that it has so far been a matter almost of impossibility to separate a sufficient quantity of these poisonous principles to purify them perfectly for chemical analysis. Perhaps this object has been attained more nearly than ever before by some workers in the Biochemic Laboratory in this city, who have succeeded in

separating from cultures of the tuberculosis germ a crystalline poison with constant melting point and a constant composition. This is not the only poison produced by the tuberculosis germ, but that it is one of the principles which is responsible for much of the trouble with this disease is beyond doubt. These special poisonous principles, which are so difficult to obtain pure, we designate by the name toxines, to distinguish them from the ptomaines and proteid substances before mentioned. Another difficulty which is always encountered in extracting the poisons of bacteria is their instability. The material with which an experiment is begun may be very poisonous, but the processes of precipitation and extraction through which it must be passed in order to obtain a desired substance are such that often, long before the final stages have been reached, the nature of the poisons has undergone an entire change due to the chemical processes which have necessarily been applied.

We have said that the poisons of the germ were synthetic products which were built up within the cell wall. Some of these easily pass through the cell wall, due probably to the greater permeability of the living membrane; others are retained within the cell wall only to pass into solution when these walls are broken down. Tetanus, diphtheria and swine plague allow this diffusion to take place very rapidly, while with other germs, like typhoid fever, anthrax, cholera, glanders, tuberculosis, the poison is produced and retained within the cell more firmly during the life of the latter. As the germs die, however, in artificial cultures, the cell walls gradually disintegrate and the poison passes out into the surrounding liquid. In the case of tuberculosis and glanders a strong solution of these cell poisons in the surrounding liquid upon which the germ has been feeding gives tuberculin and mallein, the two diagnostic agents which have been of inestimable value in detecting latent disease in men and animals and thus preventing the spread of untold evils.

Thus the warfare first began by the chemist with the microbes in identifying their character and relation to disease has been prosecuted for little more than a decade in endeavoring to detect the true character of the insidious poisons with which their arrows are tipped. To a certain extent, as we have seen, this warfare has been a successful one in so far that the poisons have been hunted and driven to their last stronghold, which, ere long, with the many workers in attack, must yield as heretofore to superior forces. But while this search for the pure poisons has been in progress the chemist has not been idle in endeavoring to counteract these poisons, the nature of which he did not thoroughly understand, but the evil effects of which were only too apparent. While Jenner in vaccination for small-pox, and Pasteur with his method of vaccination for anthrax, had shown that it was possible to protect animals and men from a virulent attack of disease by giving them first a mild attack, (though, by the way, there are a few who contend even to-day that vaccination is useless), it remained for Salmon, his assistant, and Smith in this city to demonstrate, in 1882, that the poisons of germs could be used by men and animals to fortify themselves against the attacks of these same bacteria. This could be accomplished by introducing into the circulation of the animal a small quantity of the poison of the germ, so that when the germ itself was injected the poison which it produced was without effect. What had been found true for one disease of animals proved also to be true for many others, and chemical vaccination was tried for diphtheria, tetanus, anthrax, cholera, typhoid fever, tuberculosis, glanders and a number of other diseases.

But this discovery led to another, important and far-reaching. Fodor showed that the blood serum of animals, made immune to a particular disease by injecting the animal with the poison which this germ formed, had the effect of destroying the germ of the disease. This excited renewed interest in the study of the blood, and within a few years it was demonstrated by the work of many, some in this city in the laboratories before mentioned, that this serum from previously immunized animals, not only had the property of conferring immunity upon other animals, but also of checking the disease after it had once begun. How thoroughly this fact was demonstrated, first by Behring and subsequently by Roux and others in connection with diphtheria and tetanus, has been dwelt upon often, and we know of the many thousands of lives that have been saved by the use of antitoxic serums.

To prepare these the solution of the toxins, which we have before described, are injected into different animals, preferably horses, and at the end of six to twelve weeks the blood of these animals is found to yield a serum containing substances possessing both immunizing and curative properties which we call antitoxines. The active principle of this serum is present in a comparatively small quantity, but its influence is enormous. It does not appear to be a substance which directly chemically neutralizes the poison, but counteracts its effects within the animal in some unknown way.

But some of our friends may ask: Were not these facts discovered first by the use of animals, and hence has not this knowledge, though of inestimable value to mankind, been too dearly bought? Yes, perhaps, a score or two of guinea pigs and sweet, lovely rats and mice have sacrificed their lives for humanity's sake. But this knowledge could not have been gained in any other way unless by the sacrifice of human life. What mother would hesitate to sacrifice a thousand guinea pigs for the life of her child, or, on the other hand, would wish her child to serve as the subject of experiment for others?

I have often been asked if the horses placed under this treatment for the production of antitoxines suffer. I think not and, as an illustration, will relate an incident which has come under my own observation, in the study of the antitoxins of the dread disease, tuberculosis. A well-blooded horse, gentle in every particular, except that he would run away upon the slightest provocation, seemed to be a suitable subject for some work. Accordingly he received an injection of the poison of the tuberculosis germ with the expectation that so high strung an animal would rebel against these pleasant familiarities. But he was entirely too wise for this. He submitted quietly and seemed much interested while by means of a hypodermic syringe a small quantity of the poison was ejected beneath his skin. A few days afterwards when the operation was repeated it would have been reasonable to expect that if there had been any discomfort the horse would have rebelled against the procedure. Did this happen? Not by any means. As soon as he observed the doctor appear with the syringe and bottle he trotted toward him with pleasure, stood quietly looking around with intelligence, while the injection was made and ever afterwards lent himself to the experiment with as much evident pleasure and interest as that of the investigators, apparently thoroughly appreciating its object.

It would hardly be fair to say that this dumb animal was endowed with more intelligence than some of our ill-informed but well-meaning friends, and yet would its actions not seem to indicate a high regard for scientific work and disclaimer of suffering?

Is it that they are instigated by a desire to inflict torture that scores of investigators

have sacrificed their lives in searching for the poisons of dangerous bacteria and their antitoxins? Is it inhumanity which spurs them on at imminent personal risk in their efforts, which are daily yielding new and brilliant results to find means for controlling a disease which annually causes one-seventh of the deaths of the population of the globe?

However, it is not only for protection against the two diseases, tetanus and diphtheria, just mentioned, that antitoxic serums can be prepared. Recent investigations have proved that typhoid fever, cholera, anthrax, the plague, etc., are amenable to similar treatment and in the same department in this city that chemical vaccination received its first impetus, but by workers in the Biochemic laboratory it has been demonstrated that two diseases that cause such losses to the farmers of the country may be controlled by antitoxic serums. Investigators in this same laboratory have shown also that a substance antitoxic to tuberculosis can be produced in the serum of animals when they are properly treated, which has undoubted and pronounced effect in checking experimental tuberculosis in small animals. When we inquire the character of these antitoxins we are almost as yet more in the dark than in our efforts to discover the exact nature of the poisons of germs. However, it has been possible to separate in a fairly pure form the antitoxic principle from diphtheria serum, a minute amount of which will confer immunity and the antitoxic principle of swine plague, .002 g. of which has been found to cure animals weighing 1 pound, and even a solid antitoxic-like substance for tuberculosis has been obtained in an impure form. All these solid antitoxic principles resemble each other very closely in their chemical tests and methods of separation showing albuminoid reactions, but in their curative properties they are totally independent the one of the other. The diphtheria antitoxic serum does not cure tetanus; the swine plague serum does not cure the cholera.

In the case of the venom of serpents it has been found that repeated injections will make the serum of an animal antitoxic and curative against other venoms. The antitoxic serum produced by the cobra venom will protect animals and men against the bite of the rattlesnake as well as its own bite. It would seem from this that there is a very close relationship between the poisons of venomous snakes and that immunity to one also gives protection from the other. It appears very probable also that the poisons of germs belonging to the same genus will be closely allied and that an antitoxin for one will also be an antitoxin for the other. In fact, it has been demonstrated that the products of the bacillus coli communis will protect animals from the typhoid germ to which it is closely allied. The same effect will probably be found with many other diseases where the germs are related.

The difficulty of separating these antitoxins completely from the other constituents of the blood has made it impossible as yet to obtain positive information as to their true chemical character.

As to their action in producing immunity one theory is that they directly neutralize the poisons which the germs produce, but this does not seem to be substantiated by experiment.

Another theory proposed first by Sternberg, then by Metchinkoff, ascribes immunity to the action of the white blood corpuscles upon the bacteria, while the third theory, and the one which seems most tenable in view of actual results, is that the antitoxic principle partakes of the nature of an unorganized ferment like diastase, and that its action in the body, with the aid of the leucocytes, suffices to render innocuous the poisons of the particular germs.

There is little room for doubt that in the first instance the antitoxins are the result of cell activity upon the introduced poison. Just how the cell manages to convert the toxin into antitoxic ferment is not known, probably by absorption of the toxin and subsequent secretion of the antitoxin within the cell-wall. Every added dose of toxin finds not only the leucocytes but a ferment to aid in its decomposition, and so the change proceeds more rapidly and the immunity is increased. Exactly what the chemical alteration in this instance is, has not been explained, but that there is oxidation, and molecular rearrangement of the toxin seems to be probable.

Thus without taking into consideration the destruction of the causes of disease, viz., germs themselves, by means of such excellent disinfectants as formaldehyde, has the warfare against the microbes progressed. Although as we learn more of the properties and uses of their toxins we are almost forced to confess that it is not a warfare, but rather that man is learning how to train and control these microscopic forms of life as centuries before he learned how to control the animals and higher plants.

Our ideas of germs are so thoroughly associated with disease that we often forget that these germs are but the simplest forms of plant cells which are endowed with various functions. The majority of them are not injurious to man, but very useful fellow-workers if he has once learned how to manage them. The value of this cell life in the production of wines, beer and other fermented liquids is too well known to need more than passing mention. But you may not all know to what extent the aroma and flavor of butter and cheese are due to the products of micro-organisms. Now these products are frequently ethers and esters, sometimes acid and acid derivatives or amines, the latter a class of compounds to one of which smoked herring owes its particular flavor and which is also formed by a number of bacteria.

When milk is first collected from healthy animals it is almost free from germs, but exposed to the air it soon becomes filled with those forms of life which are perfectly harmless. If placed under suitable conditions with regard to temperature they will multiply very readily and the milk becomes sour, due to the formation of lactic acid produced from the sugar in the milk by one or more of these germs. If the germs present happen to be those giving an ether and ester which have a pleasant flavor and aroma, good butter can be made, but if they give rise to the formation of disagreeable thio, ethers and esters or some amines, the butter is poor and bad

Now, by isolating different germs found in the milk and cultivating them separately, so as to discover their own peculiar product, it is possible to always make butter of the same sort and flavor by first destroying the other germs present by Pasteurization and then inoculating the cream with the particular germs desired. A number of germs have been isolated from milk which will produce good butter, and any one of them is, perhaps, as satisfactory as the other, the etheral product being slightly different and more palatable to different individuals. Of course, a great many germs have been found in milk which produce disagreeable compounds and it is not possible to tell from their appearance simply, which will be desirable plants, but it is easy to cultivate them in a small quantity of milk, note the results and select the desirable plant cells.

Fortunately or unfortunately the use of these germs has been patented, so that in the near future we may see branded upon particularly fine butter and cheese patented in 1893, amended 1896, reissued 1908, etc. May we expect soon a patented process for sterilized breathing, eating and sleeping?

Recently it has been found that malt if inoculated with a particular ferment from the skin of the grape will be converted into wine, the ferment used giving rise to the formation of characteristic ethers, so it is certainly not beyond the limits of possibilities that in the near future American beer after a voyage to France may return as excellent champagne. When we discover too a germ (as had been done recently) that converts starch into cellulose, we are almost led to wonder if it might not be possible to produce cotton in a culture flask if the particular germs were supplied with nutritious food and a sufficient amount of carbon dioxide, oxygen and water.

The flavor of many lucious fruits and foods is due to the products either directly or indirectly of one or more of these useful bacteria, and on the other hand similar germs play an important and as yet unknown rôle in the formation of poisonous alkaloids.

Many bacteria form beautifully colored substances, reds, yellows, blues, greens and delicate shades which the art of man has not been able to imitate and the nature of which he has not yet learned. These, too, are only hiding their secrets with a thin veil which investigation will soon withdraw.

But it is not only in simple industrial processes that the products of germs are important. Man's very existence, while menaced on the one hand by a few germs, is on the other dependent upon their activity. The germs which in the soil produce nitrous and nitric acid and ammonia, and aid their assimilation by the plants, those which facilitate the decomposition of phosphates and bring the phosphorous, a so necessary constituent for the life of plants and animals into an available form, and those which aid in the destruction of dead vegetable and animal matter, play a very valuable and but little appreciated part in the continuance of the life and well-being of man.

There are many other ways in which the products of these dreaded microscopic cells are useful, but all, a very insignificant number of which we have mentioned, are only waiting man's bidding to become valuable subjects, and to show that, as has been instanced in the history of nations, conquered people often make the best and wisest citizens.

E. A. de Schweinitz.

Washington, D. C.

THE GROWTH OF CHILDREN.

In the years 1891 and 1892 I collected statistics on the growth of children in Worcester, Mass., mainly with a view to investigating individual growth. Although it was not possible, as was my original intention, to continue the series through a number of years, some results of interest have been obtained. The measurements were taken partly by myself, partly by fellows and students of Clark University. I am indebted to Dr. G. M. West for many of the measurements.

The stature of the same children was measured in May, 1891, and in May, 1892. The average annual increases and the variability of the amount of growth (the mean of the squares of individual variations) for these intervals were as follows:

Average Increases in Stature of Children Between the Following Years (cm.).

	5 and 6	6 and 7	7 and 8	8 and 9	9 and 10	10 and 11	11 and 12	12 and 13	13 and 14	14 and 15	15 and 16
Boys	6.55	5.70	5.37	4.89	5.10	5.02	4.99	5.91	7.88	6.23	5.64
Girls	5.75	5.90	5.70	5.50	5.97	6.17	6.98	6.71	5.44	3.34	——

Variability of Annual Growth.

Boys	——	±0.68	±0.86	±0.96	±1.03	±0.88	±1.26	±1.86	±2.39	±2.91	±3.46
Girls	±0.88	±0.98	±1.10	±0.97	±1.23	±1.85	±1.89	±2.06	±2.89	±2.71	——

This table shows that young children grow more uniformly than older children. The increasing variability is very great during the years of adolescence. After this period it must necessarily fall. It disappears as soon as all the individuals have ceased growing. This increase in variability must be considered due to the effect of retardation and acceleration of growth. During the period preceding puberty some individuals will have reached their full growth, while others are still growing at a very rapid rate. As the rate of growth during the early years of childhood does not vary very much, retardation and acceleration will not have any effect of this sort. For the same reason the distribution of amounts of growth during the years preceding puberty is very asymmetrical and must be more so for the years from 17 to 20, for which I have no observations. It will be noticed that the growth of girls is more variable than that of boys.

I have furthermore divided the series for each year in two equal halves, the one embracing the tall children, the other embracing the short children. The average annual increases of these two groups are as follows:

AVERAGE INCREASE IN STATURE BETWEEN THE FOLLOWING YEARS:

	6 and 7	7 and 8	8 and 9	9 and 10	10 and 11	11 and 12	12 and 13	13 and 14	14 and 15	15 and 16
Short boys	5.5	5.2	4.8	4.8	4.8	4.8	5.2	7.3	7.5	6.8
Tall boys	5.9	5.5	5.0	5.4	5.3	5.2	6.6	8.5	5.0	4.4
Difference	+0.4	+0.3	+0.2	+0.6	+0.5	+0.4	+0.6	+1.2	−2.5	−2.4
Short girls	5.7	5.5	5.3	5.5	5.8	7.0	7.4	6.5	4.5	
Tall girls	6.1	5.9	5.6	6.4	6.5	7.0	6.0	4.4	2.2	
Difference	+0.4	+0.4	+0.3	+0.9	+0.7	0.0	−1.4	−2.1	−2.3	

It appears that during the early years of childhood short children grow more slowly than tall children, that is to say their general development continues to be slow. Later on, during the period of adolescence, they continue to grow while tall children have more nearly reached their full development. That is to say, small children are throughout their period of growth retarded in development, and smallness at any given period as compared to the average must in most cases be interpreted as due to slowness of development. During early life slowness of development which has manifested itself is likely to continue, while some of the effects of retardation will be made good during the period of adolescence, which is liable to be longer than in children who develop rapidly in early life.

We will call the average stature at the age t A_t; the amount of growth of an individual whose stature at that period is $A_t + x$ may be called d_x. We assume that the relation between the actual size of an individual and the average amount of its annual growth be expressed by the simple relation

$$d_x = d + ax$$

where a is a constant.

Furthermore we will assume that the variability of d_x will be the same for all values of x. Then it can easily be proved that

$$a = \sqrt{\frac{\mu_1^2 - m^2}{\mu^2}} - 1$$

where μ and μ_1 the variabilities of stature at the periods t and t_1 and where m the variability of the amount of growth during the period t_1–t.

From these data the following values of a have been computed:

Age.	Boys.	Girls.
6	0.05	0.05
7	0.05	0.05
8	0.01	0.01
9	0.03	0.03
10	0.06	0.06
11	0.06	0.07

Age.	Boys.	Girls.
12	0.10	−0.11
13	0.08	−0.17
14	−0.03	−0.20
15	−0.22	

The values cannot claim any great weight, since the series of observations is very small. Only about fifty individuals for each year and sex are available. They prove, however, that the values of a first decrease until about the eighth year. Then they increase and decrease again very rapidly after the thirteenth year in boys and after the eleventh year in girls.

According to the assumptions made before, the average individual which measured $A + x$ at the period t will measure

$$(A + x) + (d + ax) = A + d + x\frac{\mu_1}{\mu}\sqrt{1-\frac{m^2}{\mu_1^2}}$$

at the period t_1.

If it measured

$$A + d + x\frac{\mu_1}{\mu},$$

it would remain in the same percentile grade while according to the above formula its percentile standing will be nearer the average than at the initial period t. Only when all the children of the initial measurement $A + x$ grow equally, *i. e.*, if $m = 0$ could they remain in the same percentile grade. This conclusion agrees with Dr. Henry G. Beyer's observations.*

The above approximation is fairly satisfactory during the early years of childhood. During the period of adolescence it is not satisfactory, because the values of a are too large. More extended observations will enable us to include terms of higher order in the considerations and to obtain more accurate knowledge of the laws of growth.

The results of this investigation suggest that the differences of growth observed in children of different nationalities and of parents of different occupations may also be partly due to retardation or acceleration of growth, partly to differences of development in the adult stage.

In order to decide this question we may assume that in the averages obtained for all the series representing various social groups accidental deviation from the general average only occurred. Then it is possible to calculate the average deviation which would result under these conditions. When the actual differences that have been found by observation are taken into consideration another average deviation results. If the latter nearly equals the former, then the constant causes that affect each social group are few and of slight importance. If it is much larger than the former, then the causes are many and powerful. The proportion between the theoretical value of the deviation and the one obtained by observation is therefore a measure of the number and value of the causes influencing each series.

I have applied these considerations to the measurements of Boston school children obtained by Dr. H. P. Bowditch. I have used thirteen different classes in my calculations, namely, five nationalities: American, Irish, American and Irish mixed, German and English; and eight classes grouped according to nationalities and occupations: American professional, mercantile, skilled labor and unskilled labor, and the same classes among the Irish.

The results are as follows:

	Boys. Deviation.			Girls. Deviation.		
Age.	Theory.	Obs.	Ratio.	Theory.	Obs.	Ratio.
5	0.34	0.34	1.0	0.40	0.58	1.5
6	0.28	0.46	1.6	0.34	0.57	1.8
7	0.29	0.76	2.6	0.32	0.81	2.5
8	0.28	0.54	1.9	0.30	0.71	2.4
9	0.32	0.89	2.7	0.36	0.40	1.1
10	0.33	0.76	2.4	0.38	0.83	2.1
11	0.35	1.05	3.0	0.46	1.04	2.2
12	0.40	1.18	3.0	0.52	1.89	3.6
13	0.46	1.65	3.6	0.52	1.44	2.8
14	0.57	2.69	4.7	0.53	0.98	1.9
15	0.67	2.06	2.9	0.53	1.02	1.9
16	0.72	1.50	2.1	0.54	0.53	1.0

* Proc. U. S. Naval Institute, Vol. XXI., No. 2.

We see that the values obtained by actual observation are always greater than those obtained under the assumption that only accidental causes influence the averages for each class. We also see that these causes reach a maximum during the period of growth and decrease as the adult stage is reached. The maximum is found in the fourteenth year in the case of boys, in the twelfth year in the case of girls, *i. e.*, in those years in which the effects of acceleration and retardation of growth are strongest. Although the values given here cannot claim any very great weight on account of the small number of classes, this phenomenon is brought out most clearly.

The figures prove, therefore, that the differences in development between various social classes are, to a great extent, results of acceleration and retardation of growth which act in such a way that the social groups which show higher values of measurements do so on account of accelerated growth, and that they cease to grow earlier than those whose growth is in the beginning less rapid, so that there is a tendency to decreasing differences between these groups during the last years of growth.

FRANZ BOAS.

THE PROMISE AND POTENCY OF HIGH-PRESSURE STEAM.

THE writer has been so fortunate, recently, as to be permitted to study the action of exceptionally high-pressure steam in the engine, under favorable conditions, and thus to add to the record of Jacob Perkins and his sons, and of Dr. Albans and others experimenting with steam of extraordinarily high-pressure, data which represents much more satisfactorily the conditions now known by the engineer to be those essential to economic operation.*

*The 'Promise and Potency' of high-pressure steam; illustrated by the performance of the triple, and the quadruple-expansion experimental engines of Sibley College. Trans. Am. Soc. M. E., December, 1896. Vol. XVIII; No. DCCXVIII.

The progress made to date and during the century now elapsed since the introduction by James Watt of the modern type of steam-engine, as adapted to the performance of every variety of work, has been mainly through the steady advances effected in the successful management and application of steam of increasing pressure, with corresponding thermodynamic gain by increasing the ratio of expansion, and with reduction of wastes, mainly by increasing speeds of engine. The accessory gains have been through expedients for improving the lubrication, to reduce wastes of dynamic energy, and for securing better protection against external losses of thermal energy, and improvements, as by jacketing and superheating, resulting in suppression of the internal condensation, due to the action of the cylinder wall.

Increasing steam pressure gives increased mean effective pressures, and rising temperatures of steam afford gains by widening the range of adiabatic and thermodynamic transformation of energy. Superheating has not, as yet, been successfully carried so far as to permit increased thermodynamic transformation by providing a steam gas as the working fluid in the engine. It practically simply insures dryer, and thus better, working steam. Up to the present time the risings, temperatures and expansions have gone together, being limited by the conditions which give us dry and saturated steam. The result has been a steady advance for a century, both in the 'duty' of the machine and its complementary elements, thermodynamic and mechanical efficiency. Watt insisted on restricting steam pressure to seven pounds per square inch on the score of safety; we now employ from twenty to thirty times that pressure with probably no greater risk. The work described in the communication here abstracted was done at 300 to 500 pounds pressure, and the boiler employed had been

tested up to 1,350 pounds and operated, with the engine, at times, at above 600 pounds pressure. But even these working pressures are comparatively low figures beside those of Perkins, who sixty years ago operated steam engines at 1,000 and 1,500 pounds and upward, and whose disciple, Dr. Albans, built a number of engines for regular work at nearly as great tensions of steam. Owing to their incomplete expansion, and owing to the fact that they were not compounded or otherwise insured against great 'cylinder condensation,' the engines of neither of these experimentalists attained what would be to-day thought remarkable economy. It was, however, remarkable for their time.

In those early days a piston speed of '128 times the cube root of stroke' was standard practice; the figure has now risen to, in some instances, four times this figure, and standard practice ranges from 600 feet, with small 'automatics,' to 1,000 feet per minute in large engines. The size, weight and cost of the machine for any stated power have been correspondingly diminished. The main source of gain in the meantime has been the diminution of the internal thermal wastes of the machine, which constituted in the days of Watt ninety per cent. or more of the demand for steam in the old Newcomen engine which he reconstructed, thirty to forty per cent. of the steam consumption in his own engines, and which has now fallen in the best contemporary machines to about twenty per cent., still constituting an important source of loss. 'Duty' has risen from about 10,000,000 foot-pounds in the first of these series to 60,000,000 in the second, and has attained to-day about 150,000,000 and promises to become 160,000,000 at the end of the century, per hundred pounds of best coal consumed. Reduced to steam consumed, the latter figures correspond to about eleven and a-half and about eleven pounds per horse-power per hour, and, in heat expended, about as many thousand B. T. U., with high temperature feed-water with large proportion, or ten per cent. more with moderate admixture, of jacket water. In fuel, it corresponds to from $1\frac{1}{4}$ to $1\frac{3}{4}$ pounds per I. H. P. per hour. The average steam engine of even good makers seldom attains much more than one-half the efficiency of the modern record-making machines.

The triple-expansion engine of Sibley College, built and employed as an experimental engine purely, illustrates the action of good engines at about 125 pounds pressure (absolute). It gives the indicated horse power on about 13.3 pounds of steam, 15.1 per D. H. P., and 14,160 B. T. U. per hour; its total ratio of expansion being 13.83, and the jackets supplying 13.72 per cent. of the feed water. The thermodynamic efficiency of the corresponding Carnot Cycle would be 24.7 per cent.; that of the engine is 18 per cent. A low vacuum, 22 inches, makes this work still more remarkable for so small an engine. It operated at 140 I. H. P. in this case. The machine was built for 175 pounds steam—another disadvantage. The dictum of Dwelshauver-Dery and the writer, that the jackets produce best effect, and efficiency attains a maximum, when the expanding steam is dry at or before final exhaust into the condenser, is confirmed by these results. The jackets are in this engine always advantageous.

The records first given, as the present maxima, are from large engines operated at from 125 to 175 pounds pressure. Those are triple-expansion. The following are data relating to the quadruple-expansion experimental engine of Sibley College, Cornell University, operated at, in some cases, 500 pounds pressure and upward. The machine is of but twenty horse-power rating; its cylinders having diameters of respec-

tively 2.344, 3.969, 6.977 and 10.266 inches; the stroke of piston being 4.5 inches, and its speed of revolution usually about 300 per minute. The engine possesses a number of interesting and ingenious new devices introduced by its designers and builders, Messrs. Hall and Treat, graduate students of the College; and its boiler, a water-tube construction, is also original in plan.

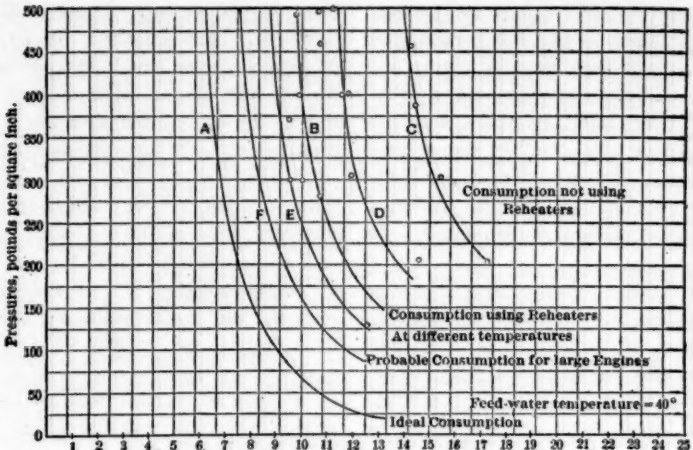
The trials of this engine, conducted under many difficulties, and often at some hazard, in consequence of perpetual trouble met with, in the early part of its history, in securing a reliable means of feeding against the high boiler-pressure, and in finding a good method of obtaining water-level indications, resulted in showing an exceedingly low steam and heat consumption. After a good feed pump had been secured, and the boiler could be handled with safety and without anxiety, and after the constructors had devised a new and reliable system of water-level indication, trials were carried on, the outcome of which has now been published. The net result was the indication of a pressure of maximum efficiency, for this engine, less than that for which it was designed, and the obtaining, at best adjustments, of an efficiency of about thirty per cent., a steam consumption of about ten pounds per I. H. P. per hour, and of 226 B. T. U. per I. H. P. per minute, 13,560 per hour, at 300 and 400 pounds pressure. The engine was provided with 'reheaters,' or drying chambers, between each pair of cylinders, and, these being thrown out and the steam worked wet, the consumption rose to from 13.7 pounds at 500 pounds pressure to 15.5 at 300 pounds, per I. H. P. per hour. The wastes in the latter case were substantially the same at high as at low pressures, and the deduction follows that we may expect at high steam pressures about as close an approximation to the ideal thermodynamic case as at ordinary tensions of steam. There still remains, however, some question as to the exact efficiency of even this engine; owing to irregularity and shortness of most of the trials, due to the difficulties with the boiler above mentioned, and some uncertainty regarding leakage past piston and valves; the existence of which is at least indicated by the measurements of the indicator diagrams.

A comparison of these figures with those of larger engines in commercial use can only be made after allowing for the comparatively large internal wastes, due to the excessive proportion of area of cylinder wall to weight of steam passing through the engine, in the case of small machines. Reducing these wastes by any probable fraction, the heat, steam and fuel consumption of the engine at its regular pressure, above thirty-three atmospheres, would give a consumption of not far from $7\frac{1}{2}$ pounds of steam per I. H. P. per hour, or from 7,500 to 8,000 B. T. U., according to temperature of feed water.

The diagram herewith presented shows the relation of the efficiency of the ideal, purely thermodynamic, engine of similar cycle—the Rankine form—to the actual performance. The curve A is that of the best ideal, case B that of the average best performance of the experimental engine, C that with its reheaters out of use, and the various observations indicated on the chart show the variations due to varying efficiency of reheating and to other variable conditions of operation. D may be taken as representing fair average performance, and E the limit of best work; while F is not far from what should be expected from large engines of similar type, and is taken as representative of the commercial attainable performance of such good practice at 500 pounds pressure and under.

These curves of relation of steam used to power produced are of the form

$$w = a / \log p;$$



— Efficiency Curves, Ideal and Actual.

where the value of a varies from 18 on the line A, to 25 on B, 30 on C, and to 22 and 24 on lines F and E; w being weight of steam per h. p. per hour, p steam pressure.

Of the figures representing efficiency, as here recorded, it is probable that those on the line C may be accepted as accurate. Those obtained with reheaters in use are obviously less certain, and may be subject to some error. On the whole, the writer considers that the assignment of the lines E and F as those to be attributed to successful practice with large engines, and as representing the 'promise and potency' of high-pressure steam, is well justified.

R. H. Thurston.

Cornell University.

THE ORIGIN OF THE TEETH OF THE MAMMALIA.

Professor H. G. Seeley, F.R.S., in a series of memoirs in the *Philosophical Transactions*, during the past three or four years, has been describing the Upper Triassic vertebrates of South Africa. Certain of these animals are upon the border line between the Reptiles and Mammals, and, as Professor Seeley points out, show a most remarkable intermingling of characters. The cranial characters, with the exception of the paired occipital condyle, are mainly reptilian; the dental characters, and this is the point to which I wish to especially draw attention, are pro-mammalian. The point of particular interest is that within this group are found *all the primitive mammalian types of teeth*. *Lycosaurus* is haplodont; *Galesaurus Cynognathus*, both members of the *Cynodontia* or Carnivorous division, are *triconodont*. The teeth are as clearly divided into incisors, canines, premolars and molars as those of the lower Jurassic mammals. The dental formula approximates that of the stem mammal. These animals parallel or are actually related to the great 'protodont-triconodont-tritubercular' phylum of mammalia, which includes the Marsupials and Placentals. In a distinct division of herbivorous reptiles, which Seeley terms the *Gomphodontia*, we find a corresponding parallel or ancestral relation to the 'multituberculate' phylum of mammals, including the Multituberculata and possibly the Monotremata. Here, in fact, actually belongs *Tritylodon*, which upon good grounds has, until recently, been considered a multitu-

berculate mammal. The teeth of *Diademodon* show an incipient division of the fang and closely resemble in the crown the alleged *Microlestes* of the Rhætic of Germany. The point of additional interest is in the superior molars of an allied form, *Gomphognathus*. These are, as Professor Seeley implies, multitubercular, but they are also *tritubercular* in pattern. It is difficult to resist the inference that the four upper cusps do not represent the protocone, paracone, metacone and hypocone. If this is supported by further discoveries it will amply demonstrate the truth of the hypothesis which I have long advocated, that multitubercular teeth are more or less degenerate derivatives of tritubercular teeth.

HENRY F. OSBORN.

MARCH 25TH.

ZOOLOGICAL NOTES.

THE SHARP-TAILED FINCHES OF MAINE.

IN the proceedings of the Portland Society of Natural History (Vol. II., March 15, 1897) Mr. A. H. Norton remarks on the distribution and relationship of the sharp-tailed finches of Maine.

He states that *Ammodramus c. subvirgatus* breeds in the swale-bordered tide rivers, in close proximity to rocky bluffs fringed with black spruce, while true *caudacutus* of southwestern Maine rears its young in the broad salt marshes along the sandy beaches. As there are none of these low marshes in the area inhabited by *subvirgatus*, it necessarily takes the only available nesting grounds; consequently the difference in the character of the home of the two birds is of no apparent significance. It is suggested that after the close of the glacial epoch *subvirgatus* followed up the receding ice until a barrier to the bird's northward migration was reached at the Gulf of St. Lawrence. From this point the overflow of individuals pressed westward along the Great Lakes and finally covered the area now occupied by *nelsoni*.

The author, in common with a few others, is of the opinion that *A. caudacutus* and *A. nelsoni* are specifically distinct, and that *subvirgatus* is a race of the later so-called species. In this we do not agree, and would consider it just as logical to separate *Melospiza fasciata* and *M. fallax* into species with *montana* as a race of the latter bird.

A. K. FISHER.

CURRENT NOTES ON PHYSIOGRAPHY.

YELLOWSTONE NATIONAL PARK.

THE Yellowstone folio of the Geologic Atlas, by Hague, Weed and Iddings, forms No. 30 of the series. It has six pages of text, three plates with eleven admirably reproduced photographs, four topographic and four geologic sheets; all at a cost of 75 cents. Apart from the wonders of the geysers, the plateaus of lava beds and volcanic breccias, deeply dissected, especially in the Absaroka range, along the eastern border of the Park, are most notable. The slender, digitate forms of some of the ancient plateau remnants are remarkably well displayed on the topographic sheets. The continental divides in two open valleys that trench across Two-ocean plateau are peculiar, one of them being the famous Two-ocean pass, where a stream from the north forms a fan at the summit of the pass, turning its water rather indifferently to Atlantic Creek on the east or to Pacific Creek on the west. The origin of this deep and rather wide valley through the plateau is not stated, and our curiosity is left unsatisfied as to the reason why the Yellowstone River, with its relatively mature and open headwater valleys, has cut a distinctly young, steep-sided canyon in its more northern course.

BEARPAW MOUNTAINS, MONTANA.

MESSRS. Weed and Pirsson describe the Bearpaw mountains of Montana (Amer. Journ. Science, I., 1896, 283–301, 351–362)

as the dissected remains of a group of Tertiary volcanoes. Seen from the surrounding plains, the mountains have a serrate outline, highest near the center of an oval area, 20 by 40 miles in diameter. Seen in plan, they exhibit a well defined system of radial valleys. The interstream peaks and ridges consist of volcanic tuffs, breccias, and flows, lying on Cretaceous strata, around a central district of laccolitic cores, dikes and bosses. The Cretaceous strata are somewhat upturned and baked around the largest laccolitic mass, and the 'contact ring' stands in bold relief, forming ridges around the igneous center.

In the absence of detailed surveys of this region, a somewhat similar type may be studied on the topographical and geological maps of the great dissected volcano, known as the Cantal, on the central plateau of France.

LAURENTIAN HIGHLANDS OF CANADA.

A REPORT by Professor F. D. Adams on the geology of a portion of the Laurentian area (Geol. Surv. Canada, VIII., 1896, pt. J) includes a brief account of the physical features of an area lying northwest of Montreal. Leaving the drift-covered valley of the St. Lawrence, underlain by paleozoic strata, the Archæan highlands rise abruptly in a line of hills, which constitute the edge or southerly limit of a great uneven plateau, gradually rising to the northwest. Its surface is undulating or mammilated; the depressions being generally filled in with drift, forming extensive flats, studded with numerous lakes, great and small. Rounded, ice-worn bosses or hills protrude through the drift, seldom rising more than three or four hundred feet above the general level, and presenting, especially when burnt over, great faces or whole summits of bare rock. The lake outlets have carved terraces in the drift-clogged valleys. Settlements are scattered over the drift plains, avoiding the rocky hills.

The date of origin of the undulating plateau is not considered; but Lawson's supposition that it is a pre-paleozoic land surface, long preserved by burial, and lately revealed by the erosion of its cover—a geographical fossil, as it were—seems to be contradicted by the well defined line of bluffs in which the Archæan rises from the St. Lawrence valley, unless this line is determined by an unmentioned fault.

MAPS OF MT. DESERT.

MESSRS. Bates, Rand and Jaques have rendered a service to the summer residents of Mt. Desert by publishing several good maps of the island; one on a scale of 1:40,000 (in a single sheet or folded in cover), another on a scale of 1:25,000 in two large sheets, and a third of Bar Harbor, on a still larger scale. All have contour lines, the first two printed in brown with the culture in the black and the water in blue. A special map of the eastern part of the island shows the mountain paths in red. All the maps are based on the Coast Survey sheets; but the names are carefully revised to accord more closely with local usage, the revision and republication being the outcome of a careful work on the Flora of Mt. Desert by Mr. E. L. Rand and collaborators. Any of the maps can be had of Mr. Waldron Bates, 40 Water street, Boston. To the more observant of the island residents, winter or summer, these maps would serve as a good base for detailed record of the supposed high-level shore lines, described by Shaler.

W. M. DAVIS.
HARVARD UNIVERSITY.

CURRENT NOTES ON ANTHROPOLOGY.

THE PROGRESS OF ANTHROPOLOGY.

THE President of the Anthropological Institute of Great Britain, Mr. E. W. Brabrook, in his annual address in January last, re-

viewed the advance of the science during the past year. He pointed out the constantly accumulating evidence to the continuity of human culture from the earliest period, and the growing certainty that the progress of the race has been constant. The importance of establishing an ethnographic bureau for the United Kingdom, analogous to our Bureau of Ethnology, was strongly emphasized, and the progress of the Ethnographic Survey was mentioned in complimentary terms. His closing remarks on 'The Problem of Transmission' are as follows:

"It has appeared to me that there is, in the minds of anthropologists, a growing tendency to discountenance inquiries into transmission, and to consider phenomena related to a particular stage of civilization arrived at by the operation of general laws, rather than as arising from communication between the people."

There is no doubt of this.

THE LUMBAR CURVE.

THE study of the lumbar curve as a point in comparative ethnic anatomy has received some attention from somatologists, but the first examination of it among the native American tribes is that by Dr. George A. Dorsey, in the Bulletin of the Essex Institute, Vol. XXVII. His specimens were drawn from tribes of the northwest coast, the Iroquois, the Ohio mounds and Peru. His conclusions are that the index of the curve is an important means of determining sex and that "it bids fair to become one of the most valuable ethnic tests known in determining the physical superiority or inferiority of any tribe or race."

Dr. Dorsey's tables and measurements are most carefully presented, and the subject is set forth with great clearness. It would appear, however, from the remarks of Cunningham which he quotes (p. 59) that these variations are due largely to habits of life, and if so this index could be only a secondary ethnic test, as such habits vary so widely in the same community.

NATIVE AMERICAN MYSTICISM.

A SYMPATHETIC but far from exhaustive study of this subject has lately appeared from the pen of Dr. L. Kuhlenbeck (Der Occultismus der nord-amerikanischen Indianer,' pp. 60, Leipzig, W. Friedrich). He points out, with entire correctness, that not only the religious observances, but the actions of the social and individual life among the Indians are constantly guided by spiritual agencies or occult forces. He compares their mental position in this respect with that of Goethe, who, in his conversations with Eckermann, so often referred to the 'demonic' powers which control events—surely an honorable comparison.

The author analyzes the mental experiences of the 'medicine men,' and quotes a number of instances of their strange powers and the processes by which these are acquired. Though the essay is lacking in the critical caution desirable in treating so obscure a subject, it is suggestive and composed in an appreciative spirit.

D. G. BRINTON.
UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR J. WILLARD GIBBS, professor of mathematical physics at Yale University, has been elected a foreign member of the Royal Society.

M. BONNIER has been elected member of the section of botany of the Paris Academy of Sciences in the room of the late M. Trécul, receiving 42 votes of the 57 cast.

THE portrait of Lord Lister, painted by Mr. W. W. Ouless, was presented to the Royal College of Surgeons on March 29th.

IT is proposed to celebrate the sixtieth anniversary of Sir George Stokes' connection with the University of Cambridge by the presenta-

tion of a bust to be executed by Mr. Thornycroft. Sir George Stokes has for nearly fifty years been Lucasian professor of mathematics in the University.

The bust of Sir Henry Acland, formerly Regius professor of medicine at Oxford, has been placed in the court of the University Museum.

Sir William Dawson the eminent geologist, late principal of McGill University, and Lady Dawson celebrated their golden wedding on March 19th.

The library of the German Astronomical Society has been purchased by a number of citizens of Bamburg and presented to the observatory.

Mr. Henry M. Paul, assistant astronomer at the U. S. Naval Observatory, and Mr. George A. Hill, computer in the office of the *Nautical Almanac*, have been appointed professors of mathematics in the navy.

The members of the New York Zoological Society have learned, with regret, of the death of Dr. A. A. van Bemmelin, late director of the Zoological Garden of Rotterdam. Besides the loss to zoological science in general, his death is a loss to the New York Zoological Park in particular. From the inception of that enterprise Dr. van Bemmelin responded most heartily to all calls made upon him for information and advice, and forwarded to the Society many closely-written pages of details regarding the status of the garden that has been developed so successfully under his direction. Although the Rotterdam garden is not quite so large as some of the other European gardens, it is very beautiful and attractive, and the highest praise that could be bestowed upon Dr. van Bemmelin is found in the statement that for more than twenty years he has been its director. The first of the four great flying cages in Europe is the one designed and constructed by him. The most recent lion house in Europe is the one erected by the Rotterdam society, under his direction, in 1894.

The funeral of Professor Sylvester took place on March 19th at the cemetery of the West London Synagogue of British Jews. The Royal Society and the London Mathematical Society were represented by Professor Michael Foster, Major Macmahon, Professor Forsyth, Professor Elliott, Dr. Hobson, Professor Greenhill, Mr. A. B. Kempe and Mr. A. H. Love.

We regret to announce the deaths of Dr. Joseph F. James, known for his writings in paleontology, botany and geology, who died of pneumonia at Hingham, Mass., on the 29th of March; of M. Antoine T. d'Abbadie, sometime President of the Paris Academy of Sciences, known for his works on geographical exploration and on geodesy; of Dr. Robert Hogg, the horticulturalist; of Mr. John Biddulph Martin, President of the Royal Statistical Society; of M. C. Contejean, of the Pasteur Institute, and of C. F. Wiepken, for sixty years director of the Oldenburg museum.

We learn from *Nature* that a meeting of presidents of various scientific societies in London was recently convened by the President and officers of the Royal Society to consider whether any, and if so what, steps should be taken to commemorate the sixtieth year of Queen Victoria's reign. It was unanimously resolved "That a fund to be called the Victoria Research Fund be established, to be administered by representatives of the various scientific societies, for the encouragement of research in all branches of science." The President of the Royal Society has communicated this resolution to the scientific societies, with a letter asking whether support would be given to it.

In addition to the nominations made by the Council of the British Association for presidents of the different sections at the forthcoming meeting at Toronto, announced in the issue of Science for February 12th (p. 251), Mr. J. Scott Keltie has been nominated as president of the geographical section. Evening lectures will be given by Professor Roberts-Austin and Professor John Milne.

The Museums Association of Great Britain meets this year at Oxford, from June 29th to July 2d, under the presidency of Professor Ray Lankester. Men of science wishing to attend or present papers should apply to the secretaries, H. M. Platnauer, the Museum, York, and E. Howarth, the Museum, Sheffield.

The eleventh annual meeting of the German

Society of Anatomists will be held at Ghent from April 24th to 27th, under the presidency of Dr. Waldeyer.

IT is stated in *Nature* that the Comité d'Organisation of the seventh International Geological Congress, to be held at St. Petersburg from August 29th to September 4th, have received so many applications from persons who are not geologists, and yet wish to obtain free railway tickets and to participate in other advantages arranged by the Russian government, that they have issued a special circular stating that the facilities offered are intended only for geologists. Excursion tickets will only be granted to persons who are known by their contributions to geology. Even with this restriction, the meeting promises to be a large one, for more than six hundred geologists have applied for tickets.

THE American Medical Association will meet in Philadelphia, beginning on June 1st. The American Medical Publishers' Association meets on the preceding day. There are said to be published in America 275 medical journals, of which 10 are issued weekly, 11 semi-monthly, 225 monthly, 6 bi-monthly, and 23 quarterly.

ACCORDING to the New York *Medical Record* the next course of ten lectures instituted by the late Professor Thomas Dent Mütter, M. D., LL. D., on 'Some Point or Points in Surgical Pathology,' will be delivered in the winter of 1899–1900, before the College of Physicians of Philadelphia. The compensation is $600. The appointment is open to the profession at large. Applications stating in full subjects of proposed lectures must be made before October 1, 1897, to the committee on Mütter Museum, John H. Brinton, M. D., chairman, northeast corner of Thirteenth and Locust streets, Philadelphia, Pa.

THE John Crerar Library of Chicago was opened to the public on April 1st. It will occupy rented rooms until the accumulated income from its endowment, which is $2,500,000, will suffice to pay for the erection of a building. The library is devoted especially to the natural, physical and social sciences and their applications.

IT is expected that the New York Legislature will pass the bill recommended by Governor Black appropriating $1,000,000 for the preservation of the Adirondack forests.

MR. FRYE has introduced a bill in the Senate creating a National Academy. The bill provides that the Academy shall be devoted to the accumulation and preservation of new discoveries and the perfection of the arts and sciences. The Academy would have five divisions: First, laws and literature; second, inscriptions, archæology and belles-lettres; third, sciences; fourth, fine arts; fifth, moral and political science. The Academy would have one hundred members and fifty foreign associate members, and in addition 100 American and 200 foreign corresponding members.

A NATIONAL German exhibition 'For the Hygiene of Childhood at Home and at School' is to be held in Breslau at the end of May.

THE following items are taken from *Natural Science*: The collections of Gustav Nachtigal from the west coast of Africa, made during 1894–95, are now exhibited in the Berlin Museum of Ethnology. The Berlin Museum für Naturkunde has received from the island of Ralum a collection of the flora and fauna made by Dr. Dahl. Mr. H. J. Ernst, an apothecary of Iceland, has presented to the State Museum, in Stockholm a valuable collection of Icelandic minerals. Mr. and Mrs. Theodore Bent, the archæological explorers, have returned from a successful expedition in Socotra. Mr. J. Whitebeard has been investigating the highland fauna of the Philippines, where he obtained a huge fruit-pigeon at a height of 6,000 feet. Mr. C. W. Andrews, of the geological department of the British Museum, has received leave of absence for nine months in order to investigate the natural history of Christmas Id.

THE Director of the United States Geological Survey has just addressed to the geologists, the topographers and all authors in the Survey a circular on the use of 'Quadrangle,' the new designation for the quadrilateral land units of the government surveys. In prosecuting the topographic and geologic survey of the United States the Geological Survey divides the land into small quadrilateral units, bounded by meridians and parallels, and from these result

atlas equivalent sheets, the paper dimensions of which are 20 by 16½ inches. The map units, the director explains, are appropriately called *sheets*, but no name has been uniformly applied to the land units, in the way, for example, in which *section* is used in the nomenclature of the General Land Office. The custom has arisen of applying the name *sheet* to the land unit also. The geologist and topographer ordinarily speak of surveying a 'sheet.' This usage is objectionable for obvious reasons. Hereafter, therefore, according to the new practice, the word *sheet* will be restricted to the designation of the map unit. Whenever the land unit, strictly speaking, *i. e.*, a quadrangular portion of the earth's surface delimited by the meridians and parallels of an atlas sheet, is referred to, the word *quadrangle* will be used (*e. g.*, 'In the southeastern corner of the quadrangle'); and in those cases where a word is desirable which does not connote definite demarcation, or which more strongly connotes land, the word *district* will be used (*e. g.*, 'The investigation of the district'). The use of these two words (*quadrangle* and *district*) in any other connection is to be avoided, recourse being had to the various synonyms, such as area, tract, region, territory, etc. The definite usages proposed will doubtless be a decided gain for clearness and uniformity.

Mr. Wolcott, of Colorado, has presented in the United States Senate a memorial from the Legislature of Colorado praying for a generous provision to enable the United States Geological Survey to continue and extend the examination of the metalliferous districts of the States and Territories and to carry forward the needed surveys. Provision is also urged for the prompt publication of the Survey's work, much of the work depending for its value upon early publication. There is a strong feeling, especially throughout the mining regions of the country, that the government should do more for the survey of the mining districts and the devlopment of the mineral resources, as is evidenced by the various propositions that were presented at the last regular session of Congress. Though much of the work of the Survey has been rendered less useful by delays in publication, the past two or three years have witnessed a marked improvement in this regard. A number of recent publications have been published with gratifying promptness, notably among them being the Seventeenth Annual Report of the Director, just issued.

We have received several further replies from scientific instrument makers in regard to the imposition of a tax on scientific instruments imported for educational institutions. Mr. J. G. Gray, President of Queen & Co., Philadelphia, writes that "it is possible from a narrow point of view that the proposed abrogation of the duty-free clause in the tariff law might benefit makers of apparatus in the United States." "But from the broader standpoint of the welfare of educational institutions in general and the advancement of science, it would be a retrograde step and a serious misfortune if it should become impossible to import free of duty, for the use of such institutions, the class of instruments and apparatus which they are now accustomed to import. Whilst we are manufacturers, we cannot but recognize that the narrow and possibly supposed interest of a few makers of scientific apparatus should not weigh against the wider and unquestioned interests of those engaged in education and original research and whose labors return many times over to the commercial community any advantage which may be granted them."

Charles Scribner's Sons have in press a work on *Philosophy of Knowledge*, by Professor G. T. Ladd, Yale University, which will be of interest both to men of science and to students of philosophy. The subjects treated may be seen from the titles of the chapters, which are as follows: I., The Problem; II., History of Opinion; III., History of Opinion (continued); IV., The Psychological View; V., Thinking and Knowing; VI., Knowledge as Feeling and Will; VII., Knowledge of Things and Knowledge of Self; VIII., Degree, Limits and Kinds of Knowledge; IX., Identity and Difference; X., Sufficient Reason; XI., Experience and the Transcendent; XII., The 'Implicates' of Knowledge; XIII., Scepticism, Agnosticism and Criticism; XIV., Alleged 'Antinomies;' XV., Truth and Error; XVI., Ethical and Æsthetical 'Momenta;' XVII., The Teleology of Knowledge; XVIII., Knowledge and Reality;

XIX., Idealism and Realism; XX., Dualism and Monism; XXI., Knowledge and the Absolute.

NEW volumes in the Contemporary Science Series, edited by Mr. Havelock Ellis and published in England by Walter Scott and in America by Charles Scribner's Sons, will include 'The New Psychology,' by Dr. E. W. Scripture; 'Psychology of the Emotions,' by Professor Th. Ribot, and 'Hallucinations and Illusions,' by Mr. E. Parrish.

THE California Academy of Sciences announces important changes in its publications. In addition to occasional extended monographs, the proceedings will be issued in several wholly independent divisions or parts; each division to be devoted to a single branch of science, or to a group of closely related sciences. There will be begun at once three divisions, viz.: for geology, for botany and for zoology, and from time to time such others as may be demanded, and as the finances of the Academy will permit. It is probable that a mathematico-physical division will be added in the near future. Papers will be issued separately and will be distributed immediately. Each title page will bear date of issue and the number in the volume of the division to which the paper belongs. The divisions will be formed in volumes, chiefly according to convenience, and with but incidental reference to time, each volume containing generally about 400 to 500 pages. The Publication Committee, charged with the general supervision of all publishing done by the Academy, consists of Professor William E. Ritter, Chairman, first Vice-President of the Academy; President David Starr Jordan, President of the Academy, and Mr. G. P. Rixford, Recording Secretary. This committee will be supplemented by editorial committees in the different departments, as now constituted, Professors Andrew C. Lawson and James Perrin Smith in geology, Professors W. R. Dudley and W. A. Setchell in botany, and President David Starr Jordan and Professor William E. Ritter in zoology. We find in the recent proceedings of the California Academy very important contributions to our knowledge of the fauna, flora and geology of the Pacific Coast, and the subjects on which papers are expected in the near future show great activity in scientific research in California.

ACCORDING to the London *Times* Mr. H. N. Thompson, Assistant Conservator of Forests in Burma, in a recent report on the forests of the Hukong valley and the Upper Namkong basin, in Upper Burma, devotes a section to the production of rubber in that region. It appears that in the Hukong valley the rubber tree is not a gregarious one; sometimes a family group of four or five trees may be seen, but, as a rule, a mature tree is found every 200 or 300 yards in the richer forests. When the tree is surrounded by dense shade it grows to enormous heights in order to get at the light, and some of those examined by Mr. Thompson were the largest trees of any species he had ever seen. In the thick forest he found no seedlings in the ground; they were invariably growing at a great height on other trees and sending their roots down towards the ground, so that the roots finally formed great supports on which the main trunk rested, while the original tree, on which the seedling was a parasite, was destroyed.

REUTER'S agency reports that the Egyptian Council of Ministers has approved of the appointment of Professor Forbes, the electrician, to examine the Nile cataracts and prepare an exhaustive report regarding the best methods of utilizing the water power available for generating electricity. Professor Forbes will commence his studies in the autumn.

THE report of the Meteorological Council to the Royal Society for the year ended March 31, 1896, has been issued as a Blue-book. We learn from the London *Times* that the report is divided into four sections: (1) Ocean Meteorology, (2) Weather Telegraphy, (3) Climatology, and (4) Miscellaneous. With respect to weather telegraphy and forecasts, it is stated that the daily weather report appeared regularly, and there was a regular display at the Meteorological Office in London of the state of the weather on British coasts. It is stated that of the total number of forecasts 55 per cent. were complete successes, 25 per cent. partial successes ('partial' meaning 'more than half') 14 per cent.

partial failures, and 6 per cent. total failures. The total percentages of successes was therefore 80. The total amount voted by Parliament during the year was £15,300, and £769 became available in addition. The expenditure was £15,187, showing a decrease of £25 as compared with 1894–95.

UNIVERSITY AND EDUCATIONAL NEWS.

It is reported in the daily papers that the subsidy given by the state to the University of California will be doubled, being hereafter $240,000 annually. Mr. Levi Strauss, of San Francisco, has endowed twenty-eight undergraduate scholarships in the University, and seven graduate scholarships, of the value of $250, have been endowed by other doners. The number of students in the University has increased from 918 in 1891–2 to 2,250 in the present year. It is again stated that the University will receive gifts amounting to $5,000,000 for buildings, of which sum $1,200,000 is promised by Mrs. Hearst, of San Francisco.

Chicago University has received a gift of $225,000 from Mrs. Mary Esther Reynolds in fulfilment of a pledge made nearly five years ago.

Dr. Hugo Münsterberg, professor of experimental psychology in Harvard University, will return to Cambridge at the opening of the next academic year. He has hitherto retained his position in the University at Freiberg, and during the past two years has been in residence at that University.

Dr. Heinrich Ries has been appointed to the Barnard Fellowship of Columbia University. He will undertake the study of the physical properties of clays.

Professor William John Sollas, F. R. S., D. Sc. Camb., Hon. LL. D., of Dublin, professor of geology in the University of Dublin, has been elected to the chair of geology at Oxford, vacant by the death of Professor Green. According to the London *Times* Professor Sollas was a foundation scholar of St. John's, Cambridge, and obtained a first class in the natural science tripos. In 1882 he was elected a Fellow of St. John's, and in 1889 was made a F. R. S. In 1878 he was awarded the proceeds of the Wollaston Endowment for his researches in fossil sponges, and in 1893 the Bigsby Medal for geological and paleontological investigations. Antecedently to his appointment at Dublin in 1883 he was first lecturer and then professor of geology and zoology in University College, Bristol. He has investigated in person many regions of Europe, America, Australia and Polynesia. He was last year sent by the Royal Society in charge of the scientific expedition to Funafuti.

Professor H. W. Hughes. M.B., M.S. (Edin.) has been appointed professor of anatomy at King's College, London.

Professor Rucker, F.R.S., has been appointed Reade lecturer at University of Cambridge for the present year. Mr. F. F. Blackman, of St. John's College, has been appointed university lecturer in botany. Dr. Arthur Willey has been elected to the Balfour studentship in animal morphology for another year.

Dr. John Yule Mackay, professor of anatomy of the University of Dundee, has been appointed principal of the College.

The Clothworkers' Company, of London, has offered £200 for five years, and Miss E. A. Ormerod offers £100 toward the emolument of the Sibthorpian professorship of rural economy at Oxford.

It appears from the report for 1896 of the New York Examination Department of the University of the State of New York, on about 400,000 papers submitted by academic students, that the increase is greater in languages than in science. Not only do English and modern languages show an increase, but also Greek and Latin, whereas six of the eleven branches of science show a decrease. Thus there is an increase of 1,304 papers in first-year Latin and a decrease of 1,322 in geography, of 1,186 in physiology and hygiene, of 907 in physical geography, of 310 in physics, Part I., of 197 in chemistry, Part I., and of 145 in botany. The causes for the decrease of the number of students studying science in our schools at a time when there is an increase in the number of those studying literature and languages should be considered by the State Science Teachers' Association at the next annual meeting.

DISCUSSION AND CORRESPONDENCE.

DIFFRACTION OF X-RAYS OBTAINED BY A NEW FORM OF CATHODE DISCHARGE.

TO THE EDITOR OF SCIENCE: Will you allow me to publish a very brief statement concerning some work which is now in progress on the diffraction of X-rays. The trouble has been in obtaining a sufficiently intense source to give diffraction bands with the very narrow slits that must be used. After considerable experimenting I have found a new method of producing the rays, by which the intensity of radiation per unit of area of radiating surface is from ten to twenty times as powerful as in the best focus tubes. A 'total radiation' equal to the large focus tubes has not yet been obtained. The rays are produced by an arc-like discharge between two very small beads of platinum in a high vacuum. The discharge bulb is only about an inch in diameter, while the radiation (which comes from an area about the size of a pinhead) is strong enough to show the bones in the forearm. The 'arc' appears to be a new form of cathode discharge and can only be produced under peculiar conditions. I am now using a tube with a platinum slit 1 mm. wide, mounted within the bulb at a distance of 2 mm. from the radiating bead. The second slit of variable width is placed at a distance of 10 cm. from the first and the photographic plate at distances varying from 10 to 30 cm. from this.

The images of the slit on the plate show a distinct dark line on each edge, which I can only explain on the supposition that interference occurs. The plate is at too great a distance from the slit for such an effect to be produced by reflection of the rays from the edges. Images of fine wires show similar phenomena.

As yet I have not succeeded in getting a maximum of the second order, possibly because of under exposure of the plates. The details of the work will appear shortly in *Wiedemann's Annalen* and *The Physical Review*. I am under great obligation to Professor Cross for his kindness in placing at my disposal the facilities of the physical laboratory of the Massachusetts Institute of Technology.

R. W. WOOD.

JAMAICA PLAINS, MASS., March 31st.

THE HEIGHT AND THE VELOCITY OF THE FLIGHT OF A FLOCK OF GEESE MIGRATING NORTHWARD.

DURING the three days ending March 22d numerous flocks of geese were seen migrating northward, or rather northeastward, since they were following the general trend of the coast line, which, in New England, is nearly northeastward north of Cape Cod. On the morning of March 22d, while Mr. A. E. Sweetland and I were measuring clouds, at the ends of a base line 1178.4 meters in length, extending from the Blue Hill Meteorological Observatory to the base of Blue Hill, we succeeded in measuring, with our cloud theodolites, the height and the velocity of flight of one of these flocks of geese. So rapid is the velocity of flight that the flock was visible to the observers only about two minutes, but during that time two sets of measurements, were taken with the theodolites on the leader of the flock. The first measurements, at 8.49 a. m., were accurately taken at the Observatory station, but were only approximate at the other station. The second measurements, at 8.50 a. m., were accurate and simultaneous at both stations. Using the second set of observations at both stations for the height and the two sets of observations at the observatory station for the velocity, the calculations gave the height as 905 feet above the Neponset River valley, or 960 feet above sea level, and the velocity of flight as 44.3 miles an hour. The direction of flight was from southwest to northeast.

The self-recording instruments at Blue Hill Observatory, 615 feet above the river valley, showed that the wind at the time of the measurements was from the west-northwest with a velocity of eight miles an hour.

The height calculated from the first set of observations at the two stations was 928 feet above the river valley. This result, though not considered strictly accurate, serves as a good check on the adopted value which is given above.

On a previous occasion as described in SCIENCE of January 1st, p. 26, we found a flock of ducks flying from the northeast at a height of 958 feet with a velocity of 47.8 miles an hour. The close agreement between the two results is sug-

gestive, though it may have been accidental.

H. Helm Clayton.

Blue Hill Meteorological Observatory,
Readville, Mass., March 25, 1897.

ARCHÆOLOGICAL DISCOVERIES MADE IN THE GRAVELS AT TRENTON.

To the Editor of Science: In Dr. Brinton's reference in your issue of March 12th to Professor Putnam's report to the Peabody Institute, he scarcely does justice to the recent archæological discoveries made by Mr. Ernest Volk in the gravels at Trenton. Dr. Brinton says, referring to Professor Putnam's description of chipped stones "found in the glacial deposits of the Delaware Valley," that "it is fair to say that geologists are not agreed about the age of these deposits." It cannot be that Dr. Brinton has Professor Putnam's recent facts clearly in mind or he would not make this remark.

For Mr. Volk's investigations have been carried on on the Lalor farm, which is clearly within the range of the 'Trenton gravels' ascribed to glacial floods by every recent geologist who has visited them, including Professors Cook, Shaler, Chamberlin and Salisbury. This farm lies fifty feet above the level of the Delaware river, and abuts directly upon it. Boulders two or three feet in diameter are lying about loose upon the surface in the immediate vicinity. Mr. Volk, under Professor Putnam's direction, has systematically dug over acres of this farm and has found hundreds of chipped pieces of argillite in the undisturbed layers of sand which are everywhere found from two to three feet below the present surface. In the upper twelve inches of the soil, where there are evidences of disturbance, great numbers of jasper and flint implements have been found, together with some argillite implements; but in the lower two feet excavated no jasper and flint implements have been found, but only argillite; thus demonstrating the correctness of Dr. C. C. Abbott's previous observations, and excluding the various extravagant theories propounded to account for their burial by natural causes; such as overturning of trees, the burrowing of animals and the cracking of the soil.

I would say that I have had the privilege of accompanying Mr. Volk during some of these excavations, and can add my testimony to his as to the genuineness and importance of these very significant discoveries. In this case there is no chance to claim that they have been buried in the talus; for in the cases which I saw with my own eyes the implements were dug up from the undisturbed strata of the sand more than one hundred feet back from the edge of the bluff.

I trust that the Philadelphia geologists and archæologists will give more personal attention to the work which Professor Putnam, through Mr. Volk, is so successfully carrying on in that disputed district. G. Frederick Wright.

[When Mr. Volk's specimens were exhibited at Buffalo Professor McGee stated in the Section that he did not consider that the age of the deposit in which they were found is positively ascertained. The sand layers overlie the gravels, and have usually been supposed to be considerably later. Mr. Volk has not found the specimens referred to in the true, undisturbed gravels.—D. G. Brinton.]

AN IMAGINARY FLEET.

To the Editor of Science: Permit me to congratulate you for the extremely just and advanced view you take of what a university should be. In your issue of March 19, p. 471, I find, to my great satisfaction, "Research is not only the primary object of the university; it is the university itself." So dominant is this sentiment in my mind that I have attempted the establishment of a department where all work, however elementary, shall be carried on after the manner of original research.

Would that the statement found on p. 473 of the above-mentioned date were true, viz., that the trustees of Cornell University are going to build me a naptha launch for the transportation of my students in paleontology; would also that the launch were forthcoming that a prominent firm writes me about, viz., one they understand the 'Cornell students' are making for me. These, with the one I *am personally* having built by Lintz & Co., Grand Rapids, Michigan, would certainly form an enviable fleet for the prosecution of paleontologic research.

G. D. Harris.

Cornell University.

THE METRIC SYSTEM.

TO THE EDITOR OF SCIENCE: Is it not a little incongruous for American scientists and scientific journals to urge upon Congress the legalization of the metric system to the exclusion of the old, while SCIENCE prints, without comment and in a quasi-editorial way, an abstract of government researches in which all weights are in ounces?* Would you not be warranted in declining any contribution in which were not given at least the metric equivalents?

BURT G. WILDER.

CORNELL UNIVERSITY.

[Men of science and scientific journals ought certainly to use the metric system when possible. The United States Department of Agriculture cannot, however, afford to lessen its usefulness and to awaken criticism by making such of its researches as are intended for the general public more technical or difficult to understand than is necessary. It is consequently not certain that the metric units should have been used in this work on metabolism so long as foods are sold by pounds and ounces. It is often useful to give the common equivalents of the metric system in order that the matter may be understood and to teach the equivalents, but it is not often desirable to give the metric equivalents of the common system. Nothing is gained in clearness for Anglo-Saxons, and, as far as missionary work goes, the long series of decimals naturally required to express ounces or feet in the metric system give it a cumbrous and forbidding aspect. ED.]

SCIENTIFIC LITERATURE.

The Formation of the Quaternary Deposits of Missouri. By JAMES E. TODD. Reports of the Missouri Geological Survey, Vol. X. [1896], pp. 113–217, with two maps, four section plates, five full-page illustrations, and five small figures in the text.

No detailed study of the Quaternary deposits of Missouri has ever been attempted, except in a few limited districts, but short references to them are scattered through all the reports of the several Geological Surveys which have, in the past, been instituted in the State. By a careful compilation of these fragmentary notes, supplemented by much personal observation, Professor Todd has collected a large body of valuable information on the later geological history of the northern portion of the state. His intimate knowledge of the general features of the Pleistocene formations as developed in other states, has enabled him to produce a very concise description, and his conclusions, in the main, seem to be fully warranted by the data given.

The Quaternary formations are classified into (1) the Bouldery Drift, (2) the Loess and Gray Loamy Clay, (3) Terrace Deposits, and (4) Alluvium.

In many respects the drift deposits of Missouri are remarkable. The till, or boulder clay, is found in the north-central portion of the State in considerable thickness, but thins thence in a southwardly direction, as also toward the Mississippi and Missouri rivers. Over a large portion of the state north of the Missouri river it is less than five feet in average thickness, "and over considerable areas consists of small, shallow, detached patches. Toward the margin of the drift it usually disappears, and gives place to sparsely scattered boulders of northern origin." There is a total absence of distinct moraines, drumlins, kames, eskers, 'kettle holes,' basins, knobs, and the other classes of irregularities of surface usually found in drift-covered regions. No buried forest beds have been reported, and but few striæ observed. Probably the most interesting part of Professor Todd's discussion of the drift proper is a description of the small driftless areas in Ralls, Pike, Lincoln and Saint Charles counties. They correspond to a similar driftless ridge studied by Leverett in Pike and Calhoun counties, in western Illinois.

The second great formation of the Quaternary deposits of Missouri is the Loess and Gray Loamy Clay. The two are considered merely as different phases of the same formation. This is shown to extend, in probable original continuity, over nearly the whole of the northern portion of the state, but to terminate southwardly at an irregular line, whose position seems to be controlled by the topography. It descends from about 950 feet above the sea, at

*Experiments upon metabolism, etc., March 26, 1897, pp. 493–496.

Kansas City, to 825 feet, at Pilot Grove, in Cooper county. Except in Lafayette, Pettis and adjoining counties, it is never far beyond the recognized limits of the drift sheet. Along the Missouri river, especially at and near Kansas City, two divisions of the *loess* are recognized. The 'higher loess' is that which has the widest extension, being found nearly everywhere in association with the drift sheet, while the 'lower loess' forms high terraces along the Missouri valley. It is the latter which has furnished most of the data concerning the *loess* which have heretofore been reported from Missouri.

Much valuable information is given of the trough of the Missouri river, and the question of its age relative to the epoch of glaciation of its vicinity is discussed in considerable detail; also, the preglacial and present valleys of the Mississippi river between Montrose and Keokuk, Iowa. The sections of the old and new gorges are especially finely executed.

In the discussion of the origin of the Missouri Pleistocene formations, the following leading problems are recognized: 1. Waterlaid character of the *loess* and gray loamy clay. 2. Great difference of level between similar deposits in Missouri and southern Illinois. 3. Vastness of gorges of the Missouri and Mississippi rivers. 4. Absence of drift in the lower Missouri. The Missouri *loess* deposits are referred to a fluvio-lacustrine origin. A barrier in the form of a rocky ridge is supposed to have formerly extended from the present divide between the Osage and Glasconade rivers, across the present course of the Missouri river, through Warren, Saint Charles, Pike and Ralls counties, to and connecting with a ridge in Pike county, Illinois. This barrier, by preventing free drainage toward the lowlands in southern Illinois, is supposed to have enabled the waters flowing away from the melting ice sheet to deposit the *loess* and loamy clay on the drift plain to the northwest of it, while a similar formation was being laid down at a much lower level in the country southeast of it.

In summing up the Quaternary history of Missouri, Chamberlin's classification of the Pleistocene formations is adopted. The major portion of the drift proper is referred to the Kansan epoch. The Aftonian interglacial epoch is scarcely represented in Missouri, but its effects may be recognized in slight valley erosion, particularly in the extreme northwestern part of the State. During the Iowan epoch the ice sheet is believed to have again advanced into territory now included in Missouri, but to a less distance than formerly. The *loess* is also referred to this epoch. The succeeding Toronto and Wisconsin epochs are inseparable in this state, but their effects consisted largely of increased depth of stream erosion.

The present writer desires to suggest that the idea that the distinctive deposit commonly known as *loess* was deposited by broad semi-lacustrine stream floods, originated from the study of flat areas where the formation was laid down as a nearly uniform sheet upon a plain. This hypothesis would not have originated upon certain other areas, for instance, the upper Mississippi region, where a *loess* of the same age as that of Missouri and nearly identical in the lithological features, mantles almost equally as uniformly, a characteristically hilly land surface. Here, undoubtedly, a purely lacustrine or possible semi-marine origin must be assumed for the waterlaid silt and loamy clay which covers hill-tops, slopes and broad flat valley-bottoms alike. It may be possible that the great difference in altitude between the *loess*-covered plain of southern Illinois and the much more elevated drift and *loess* plain of northern Missouri may be the result solely of the original altitudinal diversity of the preglacial land surface upon which they are superimposed. The supposed barrier from the Osage-Gasconade divide to the driftless ridge in Pike county, Illinois, would thus become unnecessary.

O. H. Hershey.

Angewandte Elektrochemie. Erster Band. Von Dr. Franz Peters. Hartleben's Verlag, Wien; Leipzig.

Electro-chemistry is one of the most recent subdivisions of chemical science. The study of its theoretical side has been most actively promoted and splendid results have been brought to light. Applied electro-chemistry is of even

more recent date; still, it has become the subject of very general attention. Separate or special chairs devoted to this branch have been created at several of the foreign technical schools, and journals intended for the publication of its distinctive methods and practices have been established. Efforts are now being made to gather in the widely spread literature relating to this subject. The volume before us presents a very full, although not exhaustive, treatment of all the sources of electric energy, the dynamo excepted. The author aims, in this volume, to give a concise account of the various forms of primary batteries and storage cells which have been devised at various times, and adds information in regard to the same which will prove helpful both to those who are engaged in promoting electro-chemical processes and to students who are seeking to gain for themselves as complete a knowledge of this subject as is possible. Some idea of the contents of the volume may be obtained from the following topics: A. Galvanic Batteries: 1. Batteries with one electrolyte. 2. Batteries with two electrolytes. 3. Dry batteries. 4. Normal batteries. 5. Suggestions for the construction of batteries and their components. B. Batteries serving for production of electric energy directly from carbon. C. Gas batteries. D. Thermopiles. E. Accumulators.

The author has treated his subject understandingly and has prepared a work which will prove of great value to all interested in applied electricity. It is his purpose, at an early date, to issue companion volumes, dealing with the application of electricity to metallurgy, to galvanoplastic processes, to chemical analysis and to industrial chemistry. The subject-matter in these later volumes is to be discussed in a thoroughly practical manner.

EDGAR F. SMITH.
UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC JOURNALS.

AMERICAN JOURNAL OF SCIENCE.

THE April number opens with an extended article by A. M. Mayer, giving the results of a long series of investigations of the phenomena of flotation of disks and rings of metal. The author briefly reviews the early literature on the subject and notes the erroneous statement often repeated in treatises on physics that a film of grease is necessary to float a piece of metal on a water surface. With respect to this point his results confirm the idea that the film of air which adheres to the body is essential to its floating, since rings of metals, as also rods of glass, sank in water if they had been heated and the air expelled, but regained their power of flotation after being exposed to the air for some 10 or 15 minutes. The disks experimented upon were made of aluminum, but the rings were made also of other metals, as iron, copper, brass, etc. The method of experimenting made possible the accurate determination of the depression of the water surface and also of the weight required to just break it and allow the disks or rings to sink. In the case of the rings the form of the water surface was more complex and called for special investigation. The equation of forces acting upon the disk of aluminum allowed finally of a determination of the surface tension of water, which was found to be .0791 as the mean of three determinations. With rings of different metals the value obtained was .0809. The mean of twenty-eight determinations of this constant by various physicists during the past sixty years is .0772. The surface tension of a solution of sodium chloride of a density of 1.2 was also determined and found to be .0860 (using the value .0772 for water).

George F. Becker contributes a paper on the method of computing diffusion with special reference to the diffusion in the viscous fluids as applied to geological phenomena. This is in connection with an earlier discussion by the same author on rock differentiation, published in the January number. E. O. Hovey discusses the rock of a dike in the Connecticut Triassic area, a few miles east of New Haven. This rock is remarkable in that it departs from the usual diabase character which so remarkably characterizes the Triassic igneous rocks of the entire Atlantic border. It is distinctly acid in character and seems to belong to the group of keratophyres. F. A. Gooch and C. F. Walker discuss the application of iodic acid to the analysis of iodides. The granitic rocks of the Pyramid Peak district in the Sierra Nevadas

of California are described by W. Lindgren. These include granites proper and the granodiorite, which is characterized as an intermediate type, neither a normal diorite nor a granite, but occupying a place between normal quartz-mica-diorite and quartz-monzonite; also normal diorite and gabbro from smaller areas inclosed in granodiorite or granite, or on the contact between them and the schists. It is concluded that all of the granite rocks are later than the altered sedimentary rocks described and the augite-porphyrite, though the relative age of the granite, granodiorite, diorite and gabbro, is not decisively settled. "The probability is that the intrusion both of the granite and of the granodiorite was accompanied by minor intrusions of acid and basic magmas, and that there are diorites, pegmatites and aplites, of the age of the granodiorite and of that of the granite, the latter being the older rock."

R. S. Tarr discusses the difference in the climate of the Greenland and American sides of Davis's and Baffin's Bay. The former name is proposed for the bay between Labrador and Greenland, south of Davis' Straits. When in the Arctic region in the summer of 1896 the author noted the remarkable difference in climate of the two localities, the eastern side being distinctly warmer and at a given time more free from snow and ice than the western. The cause of this is found largely in the ocean current moving northward on the Greenland coast, to which is added the influence of the winds. Remarks are also made on the changes of level of Baffin Land and its relation to glaciation. E. C. Case describes the foramina perforating the cranial region of a Permian reptile. The paper is accompanied by a series of cuts.

John Trowbridge and Theodore W. Richards discuss the temperature and ohmic resistance of gases during the oscillatory electric discharge. The paper gives the result of a series of experiments which have led the authors to conclude that "a mass of gas at low tension contained in a capillary tube may act as though it opposed a resistance of only five or six ohms to the spark of a large condenser." Plücker tubes were employed with aluminum electrodes and the voltmeter allowed of measuring the voltage up to 1,800 volts and above by approximation. A battery of from five to ten thousand storage cells was employed with a large condenser and a water resistance interposed of from five to fifty megohms. A series of tables give the number of half oscillations corresponding to varying resistances and capacities. Experiments were made with hydrogen and nitrogen gas in particular, and the evidence reached from them is summed up as follows:

"(1) The resistance of a gas at low pressure to the oscillatory discharge is equivalent to only a very small ohmic resistance. (2) This resistance is in general greater the less the quantity of electricity. (3) Down to a very small pressure this resistance decreases with the tension of the gas. (4) The form of the tube has an important effect upon the resistance of the gas. (5) With the oscillatory discharge it is evident that the electrodes produce far less effect than with the continuous discharge." Certain conclusions are also suggested as to the effect of the dissociation in diminishing the resistance of the gas experimented upon, thus tending to explain the difference of the spectra obtained under different conditions. In a following article, discussing whether a vacuum conducts electricity, Trowbridge states that his experiments lead him to believe that "a disruptive discharge of electricity encounters its chief resistance at the going-over layer between the electrodes and the medium, and that during the discharge in a highly rarified medium very little resistance is encountered."

I. C. Russell discusses the plasticity of glacial ice, with reference to recent experiments by McConnell, Kidd and Mügge. The observations made of the optical structure of the ice lead to the conclusion that "the yielding of glacial ice to pressure is due to movements along gliding planes in the granules of which it is composed." The closing article is by O. C. Marsh on the affinities of the Cretaceous bird, *Hesperornis*. He recalls his early conclusions that the hesperornis was allied to the ostriches and shows that they are confirmed by the recent discovery of a specimen showing feathers in place and these feathers are the typical plumage of an ostrich. In the notes which follow A. E. Verrill states that in the examination of a mass of the integument from the supposed

octopus cast ashore on the Florida coast, some months since, it has been shown that the mass resembles not an octopus, but rather the substance which forms the head of a sperm whale. The nature of the original animal is still in doubt, since no known species could have yielded a mass of this size, entirely free from any bony structure.

THE ASTROPHYSICAL JOURNAL, FEBRUARY.

The Absorptian of Light as a Determining Factor in the Selection of the Size of the Objective for the Great Refractor of the Potsdam Observatory: By H. C. VOGEL. The author discusses the effect of absorption upon the 'light-grasping power' of objectives of various apertures. The first part of the paper deals with the experiments for the determination of the absorption of the various varieties of glass available for large objectives. The second part consists of the application of the constants thus obtained to the determination of dimensions. Assuming the ratio of diameter of lens to thickness to be between six and seven, it is shown that an increase in aperture above 80 cm. gives very little corresponding increase of light. This is due to the additional absorption which is entailed by the increased thickness. An increase in diameter from 35 cm. to 80 cm. multiplies the light-gathering power by four, while a further increase to 100 cm. adds another factor of only 1.4. In view of the rapid increase in cost of a telescope, corresponding to an increase in size, and the smallness of this last factor, Dr. Vogel considers 80 cm. as about the most economical diameter. As the telescope is to be used chiefly for astrophysical work, it is to be corrected for photographic rays, and it is the absorption of these which determined the dimensions. The life partner of the great refractor is to be a visually corrected finder of 50 cm. aperture.

The Spectrum of Puppis: By E. C. PICKERING. As was announced in *H. C. O. Circular*, No. 12 (Ap. J., Dec., 1896), the spectrum of Puppis contains two rythmical systems of dark lines, one being the known series due to hydrogen. It was also announced that the other series is governed by a law somewhat resembling Balmer's law for hydrogen. In the present paper the writer points out that by a modification, Balmer's formula may be made to satisfy both series. The formula as ordinarily written (for Rowland's scale) is $\lambda = 3646.1 \frac{m^2}{m^2-4}$, where $m = 3, 4, 5, 6$, etc., substituting $\frac{1}{2} n = m$ we obtain $\lambda = 3646.1 \frac{n^2}{n^2-16}$, which gives the hydrogen lines when $n = 6, 8, 10, 12$, etc., and the lines of the newly discovered series when $n = 5, 7, 9, 11$, etc. In the light of this remarkable relation it seems probable that the new series is, in fact, due to hydrogen under some physical condition so far unknown upon our globe.

On the Spectrum of Puppis: By H. KAYSER. In connection with this spectrum Professor Kayser calls attention to the fact that hydrogen is the only element which has, until now, been considered to have only one series of lines. In every other case where series have been found to exist, there are two converging approximately to the same limit, each satisfying a formula of the type $\frac{1}{\lambda} = A - Bm^{-2} - Cm^{-4}$ where $m = 3, 4, 5, 6$, etc. The alkali metals have in addition a third series, brighter than these two. It has been generally supposed heretofore that the ordinary hydrogen spectrum consisted of this series. Certain considerations however seemed to contradict this. The newly found series in Puppis now fits in very neatly, converging approximately to the same point as does the old one. In the light of these developments more accurate measurements of the positions of the new lines will be of great interest.

On the Effect of Pressure in the Surrounding Gas on the Temperature of the Crater of an Electric Arc. Correction of Results in Former Paper: By W. E. WILSON and G. F. FITZGERALD. "The primary object of this research was to determine, if possible, whether the temperature of the crater in the positive carbon varies when the pressure in the surrounding gas is changed." The result is interesting as bearing directly upon the mooted question as to whether the temperature of the crater is that of boiling carbon. If such were the case we should expect a rise in the temperature of the crater with in-

creased pressure, corresponding to a rise in the boiling point of carbon. The radiation from the crater was measured with a radiomicrometer. Since the radiation varies as the fourth power of the temperature, a slight change in the latter should be noticeable. The experiments were not definitive, on account of the many difficulties encountered, but seemed to show that the temperature remained constant throughout a range of pressure of from one to seven atmospheres. At any rate, the constancy was sufficient to practically disprove the boiling-point idea. Among the chief difficulties to be met were connection currents in the apparatus, which rendered the gases so opaque as to suggest to the writers a new explanation of sun spots. The paper has the additional interest of indicating that temperature effects can not play an important part in the shifting of lines in metallic spectra when pressure is applied to the arc.

Preliminary Table of Solar Spectrum Wavelengths, XVII.: By Henry A. Rowland.

On the Comparative Value of Refracting and Reflecting Telescopes for Astrophysical Investigations: By George E. Hale. The paper, as is indicated by the title, is a discussion of the relative merits of the two forms of instruments mentioned. In addition to economy, freedom from chromatic abberation, and other advantages sometimes urged in favor of reflectors, Professor Hale brings forward that of their relative freedom from absorption. The effect of this in large refractors is discussed in the above paper by Dr. Vogel, and is shown to increase with the size. Since the percentage of absorption of a reflector is independent of its dimensions, this factor is of great importance where large apertures are concerned. The paper is accompanied by an interesting diagram, which shows, among other things, that for linear apertures greater than 90 cm. the *photographic* [light-gathering power of a reflector exceeds that of a refractor.

On a New Form of Mounting for Reflecting Telescopes Devised by the Late Arthur Cowper Ranyard: By F. L. O. Wadsworth. The writer discusses some developments of the idea of the Cassegraiman Condé proposed by Mr. Ranyard. Several forms of mounting are considered. In every case, with one exception, the polar axis is of the fork type. A mirror at the intersection of the polar and declination axis is so arranged that its plane always bisects the angle between the telescope and polar axis, so that light from the small convex mirror is always thrown up or down the polar axis (which is hollow), as may be desired.

A Support System for Large Specula: By G. W. Ritchey. In this article Mr. Ritchey describes a support system designed to reduce to a minimum the effects of flexure in large mirrors. The system is in reality a double one: 1. The back support. 2. The edge support. In the first system the mirror is considered as divided, by cylindrical surfaces perpendicular to the back of the mirror, into twelve parts of equal mass. Each part rests upon a support. Nine of these supports are counterbalanced in all positions by weighted levers, while the remaining three rest upon the cell. It is evident that if all twelve supports were counterbalanced the mirror would be in equilibrium in any position close to its normal one. If three of the supports are fixed, however, the nine remaining counterweights will be unable to take any of the weight off of the fixed supports which will, therefore, determine the plane of the mirror. The mirror will, therefore, *float* in a fixed plane. The edge support is designed upon the same general principles. There is reason to believe that the plan will combine with a perfect flotation support, a degree of stability heretofore unattained in speculum mounting.

Oxygen in the Sun: By Lewis E. Jewell. See foot-note to abstract of App. J, December, 1896, in Science, March 19th.

Minor Contributions and Notes, Reviews, Bibliography.

SOCIETIES AND ACADEMIES.

ZOOLOGICAL CLUB, UNIVERSITY OF CHICAGO, MEETING FEBRUARY 10.

ABSTRACTS OF PAPERS PRESENTED.

*On the Morphology of the Skull of the Pelycosauria and the Origin of the Mammals.** By G. Baur and E. C. Case.

*A fuller account of this paper has just been published in Anatom. Anzeiger, XIII. Band., No. 2 and 5, January 30, 1897, pp. 109–120, with three figures of the skull.

The sub-order Pelycosauria was established by Professor Cope in May, 1878, for certain Reptilia, especially *Clepsydrops* and *Dimetrodon*, from the Permian of Texas. It was said to differ from the Rhynchocephalia by the absence of the quadrato-jugal arch. At the end of the same year the order *Theromorphas* was established, as distinct from the *Rhynchocephalia*, containing the suborders *Pelycosauria* and *Anomodontia* (Owen).

The characters of this order with its two suborders were given as follows:

Theromorpha, Cope. Scapular arch consisting at least of scapula, coracoid and epicoracoid which are closely united. Pelvic arch consisting of the usual three elements, which are united throughout, closing the obturator foramen and acetabulum. Limbs with the phalanges as in the ambulatory types. Quadrate bone proximally united by suture with the adjacent elements. No quadrato-jugal arch.

Pelycosauria. Two or three sacral vertebræ; centra notochordal; intercentra usually present. Dentition full.

Anomodontia. Four or five sacral vertebræ; centra not notochordal; no intercentra. Dentition very imperfect or wanting.

The order *Theromorpha* was regarded by Professor Cope as approximating the Mammalia more closely than any other division of the Reptilia, and as probably the ancestral group from which the latter were derived.

The order *Theromora* has been admitted by nearly all paleontologists and zoologists, and the opinion of the close relationship of this group with the Mammalia has found very many supporters.

This view is not correct. It is shown that the order *Theromora* has no existence. The *Pelycosauria* cannot be brought together with the *Anomodontia*, since they have both the upper (postorbito-squamosal) and lower (quadrato-jugal) arches, like the Rhynchocephalia.

This result was reached by the study of an excellent specimen of *Dimetrodon incisivus*, Cope, collected in the spring of 1896, by Dr. E. C. Case, while in charge of the field expedition of the department of paleontology of the University of Chicago.

The following conclusions were reached, after the description of the skull and the principal portions of the skeleton:

The Affinities of the Pelycosauria.

There cannot be any doubt that *Dimetrodon* is nearest to the *Rhynchocephalia* and *Proganosauria* (*Palæohatteriidæ*). The structure of the skull, the vertebral column, and the humerus are of the same type.

The specialization of the *Pelycosauria* consists in the enormous development of the neural spines of the dorsal vertebræ, and in the reduction of the upper part of the quadrate and its nearly complete inclosure by the squamosal, prosquamosal and quadrato-jugal. *It is quite evident that the Pelycosauria with the two temporal arches, and the specialized neural spines cannot be the ancestors of mammals;* they represent a specialized side branch of a line leading from the Proganosauria to the Rhynchocephalia, which becomes extinct in the Permian.

The mammals have a single temporal (zygomatic) arch; the posterior nares are placed far back, and are roofed over the maxillary and palatine plates; the quadrate is completely coossified with the squamosal and quadrato-jugal; the occipital condyle is double, the entepicondylar foramen is present in all the generalized forms. The ancestors of mammals must show the same condition.

Seeley has combined a number of Permio-Triassic Reptilia from South Africa into an order which he calls *Gomphodontia.* These reptiles are: *Tritylodon*, Owen (always so far considered a mammal); *Diademodon*, Seeley; *Gomphognathus*, Seeley; *Micro gomphodon*, Seeley; and *Trirachodon*, Seeley.

In *Gomphognathus* we have a double occipital condyle; the posterior nares are placed far back and are roofed over by the maxillary and pterygoid plates, and there is an entepicondylar foramen. The quadrate seems to be of the reduced form; a condition we see also in the closely related *Cynognathus.*

These forms look very much like mammals and could possibly be ancestral to them. We must suppose that the condition of the palate seen in the Mammalia and *Gomphodontia* has been developed from a type which we find among the *Rhynchocephalia.* The *Crocodilia*, where we have a palate similar to that of mam-

mals, show us how such a type of palate was developed from the Rhynchocephalia, through the Belodonts and the Teleosaurs. It is possible that the *Gomphodontia* originated from the *Proganosauria*.

We are fully convinced that among these South African forms, one of which was for a long time considered a mammal, we have those reptiles which might be considered as ancestral to the mammals or at least closely related to their ancestors. Further finds and careful critical observations have to decide this.

The Cranial Region of Dimetrodon. By E. C. Case.

The paper presented additional evidence of the relationship of *Dimetrodon incisivus*, Cope, to the living and extinct Rhynohocephalia.

It was shown that in *Dimetrodon* there was a common distal opening of the eustachian tubes, as in the *Crocodilia* and aglossal *Anura*, and that this opening corresponded to a deep pit in the posterior part of the lower surface of the basisphenoid. There was a large hypophysis, which extended backward nearly as far as the tympanic region, and occupied an excavation of the lower part of the basioccipital, just as the hypophysis occupies an excavation in the basisphenoid in young *Crocodilia*. The tympanic region was not separated from the brain cavity by a wall of bone, but communicated freely as in fishes and some amphibians. A cast of a part of the brain cavity showed that the posterior region was very similar to the brain of *Sphænodon*. The nerves all occupied similar positions. The cerebellum was probably thin antero-posteriorly, elongated from side to side and elevated. There was a sharp descent of the medulla in its anterior portion, forming an angle with the part anterior to it. This angle is very apparent in the brain of *Sphænodon*, but absent in most other Reptilian brains, where the medulla is horizontal or joins the mid-brain at only a very slight angle.

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

The 261st regular meeting of the Society was held Tuesday evening, March 16, 1897.

Professor Thomas Wilson read a paper on 'A Cañon in Prehistoric Archæology,' in which he said that the more widely extended is the search for prehistoric man the greater will be found the area that he occupied, and the more profound the excavations the greater will be found the antiquity of that occupation. This is not meant to indicate that prehistoric man occupied all the area of the world, nor that, having once discovered his occupation of a certain area, an extension of the investigation would necessarily show an extension of the area. The theory maintained is that, having shown his occupation of a certain locality, investigations made in other localities, or in other portions of the same country, will show his increasing and wider distribution and occupation. It is a proposition announced by the foremost prehistoric archæologists that prehistoric man is not found in proportion to the number of sites occupied by him, nor by the density of his population, nor yet by the number of objects which he has left, but is, on the contrary, in proportion to the number of seekers. The world has hardly yet awakened to a just appreciation of the extent of the occupation of the earth by man during prehistoric times, nor yet to his antiquity. He used, as illustrations, the reports recently made by archæologists of investigations in two countries. The first, Babylon, has resulted in pushing the historic period back to a much greater antiquity. The other country, the prehistoric occupation of which has been doubted, if not denied, is Egypt, and is the result of investigations and excavations lately made by the Director-General of Antiquities in charge of the Gizeh Museum. He then detailed the investigations and results in these countries, exhibiting a rare collection, which he had obtained from Mr. de Morgan, the head of the Gizeh Museum, to whom the greatest credit is due for these researches.

Mr. R. T. Hill then read a paper on 'Some Phases of the Negro of the West Indies,' in which he described the geographic distribution, the difference in type, the social and political conditions of the negro in the several islands and groups of islands. Obeaism, or voodooism, is widespread in its practice and powerful in its influence, nearly all of the common people believing in Obeah, not only the blacks and

colored, which is the term applied to mulattoes, but the whites. A member of the City Council of Kingston was suspected of being a prominent Obeah man. The Obeah man is always flogged when detected in such practice. The object of this practice, or worship, as it is often called, is to: (1) Thwart or remove the spirits of the departed. (2) To bring success. (3) To punish enemies. (4) To prevent theft. They consist of sacrifices, charms, terrorizing and hypnotizing influences. To remove duffies or ghosts, a cock is sacrificed, and they hang up a bottle of water. To bring success they strew rice and other powders. To punish enemies they sacrifice a cock, cut off feet and head and plant the head with beak toward the door of the enemy. To prevent theft they hang up a bottle. The belief in duffies or ghosts is the most striking feature of Obeaism; charms are worked to keep the duffies in their graves and to keep them out of their homes. Sacrifices and practices of the most inhuman and revolting character are sometimes performed, and instances of human sacrifices were known. Every unexplainable act is credited to the duffies, and a negro will not answer a knock at his door after dark for fear it will prove a duffie. Many curious and interesting beliefs and customs were related. Discussed by Professor Mason, J. H. Blodgett, Drs. Frank Baker, J. H. McCormick and others.

J. H. MCCORMICK,
General Secretary.

NEW YORK ACADEMY OF SCIENCES; BIOLOGICAL SECTION, MARCH 8, 1897.

THE papers presented were:

H. E. Crampton, 'On the Ascidian Half Embryo.' His experimental studies on the egg of *Molgula manhattensis* showed that the isolated blastomeres segment in a strictly 'partial' manner, but that a gradual passage to a 'total' development ensues. As far as the early stages were concerned, Chabry, Roux and Barfurth are entirely correct in arguing for a half or 'partial' development. But Driesch, Hertwig and others are also correct in considering the end result a 'total' larva of less than the normal size. The paper will be published in full.

N. R. Harrington, 'On a Nereid from Puget Sound (Pacific coast), which lives commensally with the Hermit crab, *Eupagurus alaskensis*.' A variety of the western European species, *N. fucata*, is known to inhabit deserted whelk cells with *Eupagurus bernhardus*, and a careful comparison of the Old and the New World forms brings out resemblances in structure due to the operation of the same physiological factors. These are notably: (1) the degeneration of the muscular and cuticular layers in the posterior two-thirds of the body; (2) loss of the pigment in the same; (3) physiological factors may explain why only females are found (as yet) in this comfortable and nutritive habitat. The author surmises that the commensal form is the female epitocous type of some free living nereid.

This apparently undescribed species from the Pacific differs from *N. fucata B. inquilvina* of Wirèn in the arrangement of the paragnathi, respiratory lobes of notopodium and transverse pigment stripes.

Bashford Dean, 'A Posthumous Memoir of Professor J. S. Newberry.' This paper described new species and a new genus of North American fossil fishes, and discussed the genera *Oracanthus*, *Dactylodus*, *Polyrhizodus*, *Sandalodus* and *Petalodus*.

Among the types were species of *Cladodus*, *Oracanthus*, *Ctenacanthus*, *Stethacanthus*, *Asteroptychius*, *Dactylodus*, *Deltodus*, *Sandalodus*, *Psephodus*, *Helodus* and *Ctenodus*. *Dinichthys corrugatus* was taken as a type of a new genus, *Stenognathus*.

At the conclusion of the papers an election of sectional officers was held. Professor E. B. Wilson was elected Chairman for the ensuing year and Professor C. L. Bristol Secretary.

BASHFORD DEAN,
Secretary pro tem.

TORREY BOTANICAL CLUB, FEBRUARY 24, 1897.

THE first paper was by Mr. Arthur Hollick, 'A fossil *Arundo* from Staten Island.' The paper was presented by Dr. Britton, with prefatory remarks referring to this discovery. Its occurrence was in yellow sand of Staten Island, belonging to late Tertiary or early Quaternary; the locality, a pit near Port Wadsworth. The preliminary reference to *Phragmites* is now changed by Mr. Hollick to the tropical genus Arundo.

Mr. E. O. Wooton made 'Remarks on some of the rarer Plants of New Mexico,' sketching briefly the botanical regions of New Mexico, and tracing upon a map the routes traversed by most of the botanical collectors who have visited them. Mr. Wooton was himself practically the first to make collections in the southeast section of the Territory, a very interesting, botanical region, with high mountains, some of which were illustrated by photographs. Specimens of Mr. Wooton's collecting were then shown, exhibiting about thirty-five flowering plants and ferns, and including, among those familiar in the East, *Pellæa atropurpurea*, *Cystopteris fragitis*, *Pteris aquilina* and *Cheilanthes tomentosa*.

Mr. Rydberg compared some of the features presented by the sand region of central Nebraska; referred to *Muhlenbergia pungens* and other so-called '*blow-out* grasses' of the sand-hills, and described the formation of the characteristic 'blow-outs' or hollows, originating in spots where the grasses had died out and deepening rapidly, sometimes to 300 feet, producing a country where the hills are moving every year, and where he, when camping, could find no fuel except roots of sand-cherries exposed along fresh 'blow-outs.'

Dr. H. M. Richards spoke 'On Some of the Reactions of Plants Toward Injury,' as shown by his experiments in Germany last summer. Diagrams illustrating the effect of injury upon both respiration and temperature were shown. In the former case it was seen that the respiration is greatly increased by wounding, attaining its maximum about 24 hours after the injury was inflicted; this increase depending both on the stimulus of the wound itself and upon the access of atmospheric oxygen to the tissues. The occurrence of a corresponding rise in temperature, of a local nature, was also briefly referred to; the temperature curve corresponding closely to that described by the increased respiratory activity. The thermo-electric apparatus used was described; its delicacy is such as to indicate a difference of $\frac{1}{100}$ of a degree; the result with potatoes showing a maximum rise of temperature of a little over $\frac{3}{10}$ of a degree at the end of the second day, falling to the end of the fifth day. A remarkable temperature rise in the onion of nearly $3\frac{1}{2}$ degrees was explained by the fact that here the rise was not local, but affected the whole onion, in accordance with the morphological structure, and with the fact that metabolism is carried on very fast in the onion.

The next paper was a contribution from Dr. Alexander Zahlbrückner, of Vienna, a corresponding member of the Club, entitled, 'Revisio Lobeliacearum Boliviensium hucusque cognitarum.' The paper, which is in Latin, enumerates all the species, giving synonymy and references to the literature, and cites collectors and their numbers. There are 39 species, as follows: 9 in *Centropogon*, 2 new; 20 in *Siphocampylos*, 7 new; 1 in *Laurentia*; 2 in *Rhizocephalum*; 3 in *Hypsela*; 4 in *Lobelia*.

EDWARD S. BURGESS,
Secretary.

NEW BOOKS.

Agriculture in some of its Relations to Chemistry. F. H. STORER. New York, Charles Scribner's Sons. 1897. Seventh edition, revised and enlarged. Three Volumes. Pp. iv+610, iv+602, vi+679. $5.

Stones for Building and Decoration. GEORGE P. MERRILL. New York, John Wiley & Sons. 1897. Second edition, revised and enlarged. Pp. ix+506. $5.

The Elements of Physics. Vol. III. *Light and Sound.* EDWARD L. NICHOLS and WILLIAM S. FRANKLIN. New York and London, The Macmillan Co. 1897. Pp. vii+201. $1.50.

The Outlines of Physics. EDWARD L. NICHOLS. New York and London, The Macmillan Co. 1897. Pp. xi+452. $1.40.

Hypnotism. ALBERT MOLL. London, Walter Scott, Ltd. 1897. Fourth edition, revised and enlarged. Pp. x+448. 1s 6d.

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Les gaz de l'atmosphère. H. HENRIET. Paris, Gauthier-villars et Fils, Masson et cie. Pp. 192.

Anleitung zur Mikrochemischen Analyse der Wichtigsten organischen Verbindungen. H. BEHRENS. Hamburg and Leipzig, Leopold Voss. 1897. Viertes Heft. Pp. vii+129. M 4.50.